

**Archaeological Remote-Sensing Survey of a
Proposed Pipeline Area Offshore of Rehoboth Beach
Sussex County, Delaware**



Submitted to:

**GHD, Inc.
16701 Melford Blvd. Suite 330
Bowie, Maryland 20715**

Submitted by:

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8 September 2011

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Gordon P. Watts, Jr., Ph.D., RPA
Principal Investigator

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Abstract

GHD, Inc. has been retained by the City of Rehoboth Beach to evaluate the environmental impact of an ocean outfall for disposal of treated effluent from the Rehoboth Beach Wastewater Treatment Plant. In order to determine the proposed project's effects on potentially significant submerged cultural resources, GHD contracted with Tidewater Atlantic Research, Inc. (TAR) of Washington, North Carolina to conduct a magnetometer and side scan sonar survey of an area around the proposed outfall pipes. In conjunction with previous fieldwork, a program of historical and documentary research was conducted to provide a proper framework for submerged cultural resource assessment in the Rehoboth Beach area. Fieldwork activities were carried out during 11 through 15 July 2011. Analysis of the remote-sensing data revealed a total of 23 magnetic anomalies and 8 sonar targets. Twenty magnetic anomalies and 6 sonar targets are suggestive of isolated modern debris and no additional investigation is recommended. The signature characteristics of three magnetic anomalies and two sonar targets should be considered indicative of potentially significant cultural material. While not in the immediate vicinity of the proposed outfall pipes, the objects producing these signatures should be protected by a 200-foot radius buffer. Should avoidance prove impossible, additional investigation, designed to evaluate the material in terms of National Register of Historic Places eligibility, should be conducted.

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Introduction

GHD, Inc. has been retained by the City of Rehoboth Beach to evaluate the environmental impact of an ocean outfall for disposal of treated effluent from the Rehoboth Beach Wastewater Treatment Plant. The location of the project is an area offshore of Rehoboth Beach, Sussex County, Delaware. In order to determine the proposed project's effects on potentially significant submerged cultural resources, GHD contracted with Tidewater Atlantic Research, Inc. (TAR) of Washington, North Carolina to conduct a cesium-vapor magnetometer and side scan sonar survey of the proposed project area.

The remote-sensing investigation conducted by TAR was designed to provide accurate and reliable identification, assessment, and documentation of submerged cultural resources in the study area. Analysis of the data was designed to identify and assess the potential significance of anomalies and determine the necessity for additional investigation designed to generate data to support a determination of National Register of Historic Places (NRHP) eligibility. The investigation complies with Federal mandates established in Section 106 of the National Historic Preservation Act of 1966, as amended (PL 89-665); Executive Order 11593; Department of the Interior Standards, 36 CFR part 61, 36 CFR part 79; the Archaeological and Historic Preservation Act of 1979, as amended; the Abandoned Shipwreck Act of 1987, and the Advisory Council on Historic Preservation revised 36 CFR, Part 800. The survey was carried out in compliance with the Guidelines for Architectural and Archaeological Surveys in Delaware. Results of the investigation furnish GHD with the archaeological data essential to comply with submerged cultural resource legislation and regulations.

The work performed consisted of a background literature review, a check of the Delaware cesium-vapor marine magnetometer and side scan sonar survey, data analysis and preparation of a report. Field survey activities were carried out between 11 and 15 July 2011. Analysis of the remote-sensing data revealed a total of 23 magnetic anomalies and 8 sonar targets. Twenty magnetic anomalies and 6 sonar targets are suggestive of isolated modern debris and no additional investigation is recommended. The signature characteristics of three magnetic anomalies and two sonar targets should be considered indicative of potentially significant cultural material. While not in the immediate vicinity of the proposed outfall pipes, the objects producing these signatures should be protected by a 200-foot radius buffer. Should avoidance prove impossible, additional investigation, designed to evaluate the material in terms of NRHP eligibility, should be conducted.

Project personnel consisted of Dr. Gordon P. Watts, Jr., principal investigator, and archaeologist/remote-sensing operator Joshua Daniel. Data analysis was carried out by Dr. Watts and Mr. Daniel. Prehistoric research was conducted by Dr. Darrin Lowery, and Mr. Michael McCleary examined the submerged cultural resource reports in the collections maintained by the Delaware State Historic Preservation Officer (SHPO). Historical research was conducted by Dr. Watts, Mr. Daniel, and historian Robin Arnold. This report was prepared by Dr. Watts, Mr. Daniel, Dr. Lowery, and Ms. Arnold.

Project Location

The proposed project is composed of an area located in the coastal waters of Sussex County, Delaware. The survey area is located approximately 500 feet east of Rehoboth Beach and is a rectangle measuring 6,164 feet long, 3,471 feet wide and covers an area of 490.38 acres. Water depth within the study area ranged from 20 and 42 feet (MLW).

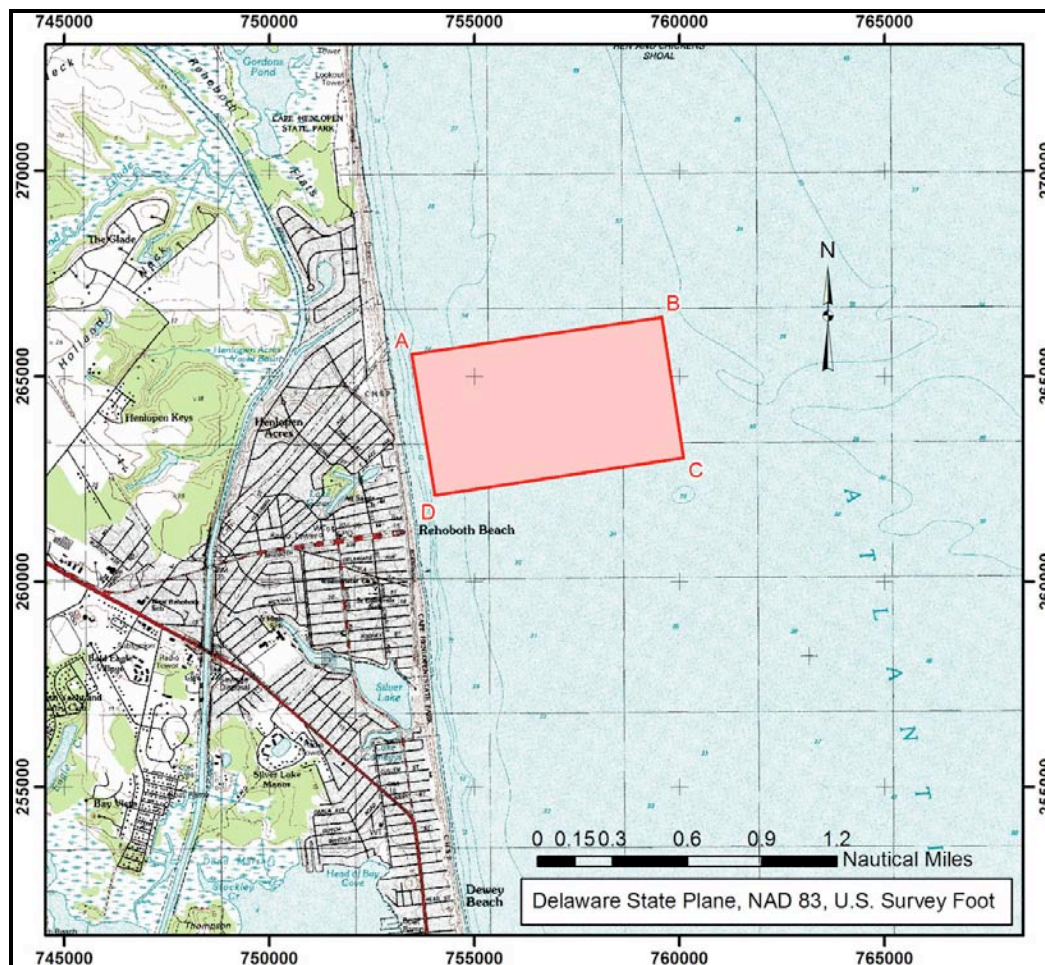


Figure 1. Project location map (USGS. "Rehoboth Beach, Delaware quadrangle" 1:24,000).

The Delaware State Plane, NAD 83, U.S. Survey Foot coordinates for the surveyed area are:

Point	X	Y
A	753471.72	265534.97
B	759568.73	266442.62
C	760100.40	263012.74
D	754031.54	262104.58

Survey Environmental Conditions

During the Rehoboth Beach survey, weather was warm with temperatures ranging from approximately 78 degrees early in the morning to about 90 degrees by mid-afternoon. Winds were light and variable from the west and northwest. Sea states ranged from calm to approximately two feet. Visibility exceeded 10 miles during survey operations.

Literature and Historical Research Methodology

In conjunction with previous activities in the project area, TAR personnel conducted a literature and records search to identify shipwrecks and historical data to support development of a general background history for the project area. TAR initiated that research by examining source material in its research library gathered from previous investigations of the area. The survey focused on documentation of activities such as exploration, colonization, development, agriculture, industry, trade, shipbuilding, commerce, warfare, transportation and fishing that would have been contributing factors in the loss of vessels in the vicinity of the proposed project area.

Preliminary wreck specific information was collected from secondary sources that include: *The Encyclopedia of American Shipwrecks* (Berman 1972); *Merchant Steam Vessels of the United States 1790 - 1868* (Lytle and Holdcamper 1952); *Disasters to American Vessels, Sail and Steam, 1841-1846* (Lockhead 1954); *Shipwrecks of the Civil War: The Encyclopedia of Union and Confederate Naval Losses* (Shomette 1973); and *Shipwrecks in the Americas* (Marx 1983). Additional information was generated by a survey of maritime records associated with the Automated Wreck and Obstruction Information System (AWOIS) of the U. S. Coast Survey.

Ms. Alice Guarrant in the office of the SHPO in Dover was consulted to determine if any surveys or previously reported sites were located in the project area and if any sites were listed on the National Register of Historic Places (NRHP). The Sussex County, Delaware index of the online National Register Information System was also queried. Submerged cultural resource reports for the project area in the collections of the Delaware SHPO were examined and copies made of relevant survey documents.

Geomorphological and Environmental Implications

Examination of the study area geomorphology and environment provides some insight into the nature and condition of submerged cultural resources that could be responsible for the remote-sensing targets identified during magnetometer survey operations. High rates of shoreline erosion and the well-documented destructive activities of modern storms suggest that material associated with both prehistoric and modern habitation of the sandy barrier complexes could have been redeposited in the survey area. Although studies of coastal change

along the western Delaware Bay shoreline confirm the high-energy nature of the environment, this does not necessarily mean that the integrity of the archaeological record associated with submerged cultural resources in the study area would be completely destroyed.

In the case of prehistoric and historic period habitation sites, it is possible that the inundation process would have resulted in extensive resorting of the archaeological record. While artifacts preserved in the bottom sediments could exist in an excellent state of preservation, the associated context of human activity may have been destroyed. However, this is not always the case. Evidence from inundated Karst formation sites in Sarasota County, Florida (Clausen et al. 1975; Cockrell 1981) and in the Gulf of Mexico off Fort Meyers (Ruppe 1979) confirms that the archaeological record associated with prehistoric sites is not always destroyed. Archaeological evidence from an inundated colonial North Carolina port suggests that many features associated with historic habitation sites can survive to preserve valuable archaeological evidence (Watts 1984a). Much depends on the local conditions and insufficient evidence has been generated to support broad generalizations.

The effect of geomorphology and environment on shipwreck material can be quite different. In most cases the remains of shipwrecks are not subjected to the processes of inundation. Shipwreck material deposited in shallow-water environments, such as the study area under consideration, can settle rapidly into the bottom sediment with its associated archaeological record intact. The wreck of the Dutch East Indiaman *Amsterdam*, which grounded off the British channel coast in 1747, provides a classic example (Marsden 1975). Even in extremely high-energy environments, evidence of the ship structure almost inevitably survives. Investigation of a variety of shipwrecks in North Carolina and sixteenth century Spanish plate fleet vessels on the Texas coast can be considered as additional examples (Arnold 1976, Delgado 1985, Watts 1975 and 1984b). In each of these cases, ship remains survived to preserve information as important as that concerning the vessel-associated artifacts. At each site sand and mud similar to the bottom sediments in the survey areas provided an excellent environment for preservation. A local example of the high degree of preservation that exists even in high-energy environments can be found in the material record salvaged from the remains of the HMS *Debraak*, lost off Cape Henlopen at the mouth of the Delaware Bay (Shomette 1993). Given the level of maritime activity in the Delaware Bay, the extent of ship losses in the vicinity of the study area, and the level of preservation at shipwreck sites in other high-energy environments, it is possible that well-preserved shipwreck sites could be responsible for a number of the anomalies identified by remote-sensing.

Delmarva Prehistoric Background

The prehistoric cultural sequence of Delaware and Maryland is generally understood (Custer 1984 and 1989, Dent 1995, and Kraft 2001) through archaeological survey and excavation. With respect to the some portions of the Delmarva Peninsula, limited research has been conducted to address and

synthesize its unique prehistoric cultural sequence (Lowery 2001 and 2003a, Rountree and Davidson 1997, William and Mary Center for Archaeological Research 1999, and Wittkofski 1982 and 1988). The following is a brief overview of the cultural sequence of these regions. The dating scheme for this synthesis is presented in calibrated calendar years (Roberts 1998:253) with respect to the radiometric-age equivalents generally associated with the recognized prehistoric cultural periods (Custer 1989, Dent 1995).

Regional Prehistoric Cultural and Environmental Overview

Paleo-American and Paleoindian Periods (>19,000-11,600 Cal. Yr. BP)

Paleoindian occupations at the Paw Paw Cove site in Maryland, dating to approximately 13,200 years BP through 12,900 years BP, are presently the only well excavated evidence for early human occupation on the Delmarva Peninsula (Lowery 2002). Even so, numerous additional sites on the Delmarva Peninsula have been reported that have revealed Paleoindian archaeological remains (Lowery 2003b and 2004a).

The Paw Paw Cove site is located along the west side of the Delmarva Peninsula and it includes a series of individual localities that have produced numerous fluted Clovis points and fragments, a limited amount of debitage or stone tool manufacturing waste, and variety of formal flake tools in eroded shoreline and buried contexts. Presently, these localities are situated along the shoreline of the Chesapeake Bay. In the past these localities were situated within the upland interfluvial areas and located around several springs and spring-fed wetlands. Given the Paleoindian artifact assemblage found at Paw Paw Cove, the site represents a series of reoccupied upland hunting-related base camps.

Additional Paleoindian sites have been found south along the main trunk of the modern Chesapeake Bay with settings identical to Paw Paw Cove. The Meekins Neck site is a drowned upland interfluvial setting. Like Paw Paw Cove, the site has also revealed numerous Clovis points, formal flake tools, and only a few fragments of lithic waste or debitage. Like many of the Paleoindian sites on Delmarva, the Meekins Neck site also seems to represent a series of reoccupied upland hunting-related base camps.

It is likely, however, that people were here earlier than Clovis and that other intact Paleoindian era sites remain to be discovered. Evidence suggests that humans reached southern Virginia by at least 18,000 calendar years BP (McAvoy and McAvoy 1997). At the Cactus Hill site in Sussex County, Virginia, McAvoy and McAvoy (1997) have found a cultural stratum with unfluted lanceolate projectile points and quartzite blades, which has been dated to the terminal phase of the last glacial maximum. The pre-Clovis cultural stratum at Cactus Hill is also situated stratigraphically below a Clovis occupation surface. The early artifacts found at Cactus Hill seem to indicate an early human presence here in the Middle Atlantic region. A pre-Clovis presence in the region is

substantiated by discoveries made at sites on the Delmarva Peninsula (Lowery 2009 and Lowery et al. 2010). At the Miles Point site in Maryland, artifacts were found at the base of a paleosol dated by both C14 and OSL methods to circa 24,000 years BP. In tandem, a large bi-pointed knife and a mastodon skull were exhumed from a -74 meter bathymetric depth on the continental shelf the Norfolk Canyon. Region sea level curves would suggest that the artifact is at least 14,500 years old. Like the Miles Point site, bone collagen from the mastodon tusk was C14-dated to circa 24,000 years BP. Data would suggest that people were present in the Middle Atlantic region during the coldest episode of the last glacial maximum circa 27,500 to 23,000 years BP.

With respect to the lifeways of these ancient cultures, some people have argued that the first inhabitants were fairly dispersed and highly mobile, relying mostly on game resources and using open campsites for habitation (Custer 1989, and Dent 1995). Custer (1989) has emphasized that Paleoindians utilized cryptocrystalline lithic materials from primary quarries located at the northern extreme portion of the Delmarva Peninsula and only supplemented their need for stone tools with secondary cobble sources along the southern sections of the Chesapeake Bay. Custer and Stewart (1990) have developed a model for Paleoindian settlement within the Middle Atlantic region with hypothesized band territories. Lowery and Custer (1990) suggested a cyclical movement pattern for the Delmarva Peninsula. Current research (Lowery 2002) has challenged some of these earlier views. This new research has suggested fairly restricted movement patterns for Clovis-age peoples living on the Delmarva Peninsula, with stone tool technologies oriented around primary coastal plain lithic materials (i.e, orthoquartzite, petrified wood, silicified sediments) and a variety of secondary paleochannel cobble lithic materials (Figure 2).

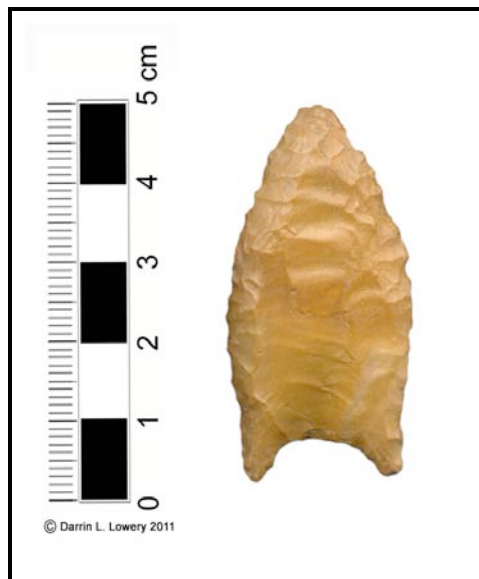


Figure 2. A Cobble Jasper Middle to Late Paleoindian-Age Fluted Projectile Point found along the Coast near Rehoboth Beach, Delaware.

There is geomorphological and paleoclimatic evidence that a major episode of loess deposition occurred after 12,900 years BP. The parent material for the loess seems to have been outwash in the ancestral Susquehanna River valley reworked by intense winds. The loess seems to have been deposited over a large section of the upland along the northwestern part of the Delmarva Peninsula (Foss et al. 1978; Lowery 2002; and Lowery et al. 2010). An ancient landscape is buried beneath the loess that blanketed the region during the Younger Dryas cold period. Since humans were in the region 13,000 years ago, it is probable that most of the Paleoindian sites in the northwestern sections of Delmarva are buried beneath Younger Dryas era loess deposits (ibid). In the interior sandy sections of the Delmarva Peninsula, eolian processes may have been reworking and depositing former marine and fluvial sands as late glacial dune landforms (Markewich and Markewich 1994; Markewich et al. 2009; Lowery et al. 2011a). Presently, Paleoindian era sites in the interior Delmarva drainage divide would be associated with a mixture of deflated landscapes and buried landscapes.

During the last glacial maximum, sea level was at least 100 meters (328 feet) or more lower than present. During the early period of human occupation at Cactus Hill, sea level in the Middle Atlantic should have risen, but would have ranged between 90 (296 feet) and 100 meters (328 feet) lower than present. During the initial Clovis occupation in the region, sea levels had continued to rise. The isostatic sea levels in the Middle Atlantic were 55 meters (180 feet) lower circa 13,500 years ago. In contrast, the global eustatic sea levels for this same time were 65 (213 feet) to 60 meters (196 feet) lower than present. The five (16 feet) to ten (33 feet) meter discrepancy noted between the isostatic and eustatic datasets has been explained by an isotatic depression that seems to have impacted the area as a byproduct of the collapse of the LGM glacial forebulge (Lowery et al. 2011b). However, by the end of the Paleoindian period eustatic sea level was around 55 meters (180 feet) lower than present. In contrast, isostatic sea level circa 11,600 years ago for the Middle Atlantic coast was around 40 meters (131 feet) lower. Considering the degree of sea level rise, it is not surprising that virtually all of the known Paleoindian sites on the Delmarva Peninsula are in upland terrestrial areas situated near interfluves. While some of this distribution along watershed divides reflects real settlement preferences, particularly access to fresh-water, the Paleoindian settlement patterns along the coastal plain are highly biased by terminal Pleistocene and Holocene marine transgression. Currently we do not have substantive Paleoindian settlement data for the floodplain and river settings, the major river confluence points, and the coastal environments of the Delmarva coastal plain. With respect to coastal environments during the Paleoindian period, we do know that the types of shellfish resources attractive to later peoples were readily available to these Late Glacial cultures on the continental shelf east of the present coastline (Thieler et al. 2000).

Early Archaic Period (11,600-9,900 Cal. Yr. BP)

Early Archaic occupations at the Paw Paw Cove site (Lowery 2002) and the Crane Point site in Maryland (Lowery and Custer 1990), as well as the Hughes Complex in Delaware (Lowery 1999), presently provide some of the best

published archaeological evidence for Early Archaic era human occupation on the Delmarva Peninsula. However, many additional Early Archaic sites are located throughout the Delmarva Peninsula remain unpublished or have been only marginally studied (Custer 1986 and 1989; Lowery 1999).

The Crane Point site and the Hughes Complex sites include assemblages made up of large numbers of projectile points, knives, debitage, formal flake tools, specialized scraping tools, flaked stone adzes, gouges, or celts, bola stones, and some plant processing tools. Both of these sites or site complexes seem to represent repeatedly occupied hunting-related base camp locations. Like the earlier sites, the Early Archaic encampments seem to be focused around the drainage divide or interfluvial areas.

The regional site data seem to indicate larger human populations during the early Holocene compared to the population levels observed for the late Pleistocene. Like the Paleoindian era, some researchers have argued that the Early Archaic inhabitants were highly mobile, relying on plant and animal resources and using open campsites for habitation (Custer 1989; Dent 1995). McAvoy (1992) and McAvoy and McAvoy (1997) have suggested that the Early Archaic groups living in Virginia were far more mobile than their Paleoindian predecessors. Unlike the Paleoindian period, Early Archaic peoples heavily utilized cryptocrystalline lithic materials from the primary quarries located near the northern extreme portion of the Delmarva Peninsula (Lowery and Custer 1990). Other primary lithic quarry materials, such as silicified rhyolite and silicified tuff, have been found fairly regularly in Early Archaic assemblages here on the Delmarva Peninsula. These materials originated from either southern Virginia or North Carolina. Secondary cobble sources and primary lithic resources within the coastal plain seem to have only supplemented the Early Archaic stone tool kits found on the peninsula. During the Early Archaic period, exotic cryptocrystalline and exotic non-cryptocrystalline lithic materials seem to be the focal points for stone tool manufacture (Custer 1986). Long-distance cyclical movement patterns are indicated for the Early Archaic-era cultures living on the Delmarva Peninsula (Lowery and Custer 1990). Models for Early Archaic settlement patterns and demography have been proposed for portions of the Middle Atlantic region (Custer 1990; Parker 1990).

Around 11,600 years BP on the Delmarva Peninsula, the vegetation changes, which can be linked to climatic warming, mark the beginning of the Holocene (Kellogg and Custer 1994; McWeeny and Kellogg 2001). In the coastal plain, there is again some evidence for eolian reworking and depositing sands along inland dunes (Markewich and Markewich 1994; Ivester et al. 2001; Otvos and Price 2001). Some have suggested that the Holocene dune building and reworking activity was limited to the crests of some of the thick dunes (Ivester et al. 2001).

Based on the suggested eolian activity during this period, it is arguable that some of the Early Archaic sites in the interior sandy sections of Delmarva are buried beneath locally reworked sands. Lowery and Custer's (1990) work at the Crane Point site indicates that the Pleistocene-age loess sediments were reworked, a

process which seems to have buried a hearth feature with diagnostic stone tools. Current evidence suggests Early Archaic era sites on the Delmarva Peninsula should include a mixture of deflated landscapes, as well as buried landscapes. It is suggested that deflation of the region's landscapes may have been associated with historic-era agricultural processes, which may have greatly impacted the observed overall patterning of Early Archaic era sites. For example, Custer's (1986:Figure 3) distribution of sites illustrates a dense accumulation of Early Archaic-era settlements in the interior drainage divide of the peninsula. These sites are associated with very sandy soils that are more easily susceptible to agriculturally induced erosion (Lowery 2001:162-169). Like the regional Paleoindian site data, the Early Archaic era sites located in the silt-loam dominated areas near the Chesapeake Bay are commonly found as shallow buried or partially buried deposits due to localized reworking of the parent loess deposits (Lowery and Custer 1990; Lowery 2002).

During the early phase of the Early Archaic period circa 11,600 years BP, global eustatic sea levels were approximately 55 meters (148 feet) lower. Over a short 500 year period global sea levels rose to within 40 meters (131 feet) below present levels. At the terminus of the Early Archaic period around 9,900 years ago, eustatic sea levels were approximately 33 meters (108 feet) lower than present (see Stright 1995). Isostatic sea level data for the Delmarva Peninsula suggests that 11,600 years ago sea levels were 40 meters (131 feet) lower. However, Delmarva's sea level circa 9,900 years ago seems to be on par with the observed global eustatic benchmark of -33 meters. It would seem that the depression which followed the LGM forebulge had finally stabilized via isostatic crustal rebound. Again, virtually all of the known terrestrial Early Archaic sites on the Delmarva Peninsula are in areas that were upland settings when these sites were occupied. The settlement patterns that we see along the coastal plain for this period are highly biased by marine transgression, as we do not yet have substantive data for the major floodplain and river settings, the major river confluence points, and the coastal environments of the early Holocene period. We do know that shellfish resources were readily available to these early cultures within the developing Chesapeake Bay (Cronin 2000).

Middle Archaic Period (9,900-6,500 Cal. Yr. BP)

Middle Archaic occupations at 18DO279-east in Dorchester County, Maryland (Lowery 1999), as well as the Chance site in Somerset County, Maryland (Cresthull 1971 and 1972) currently provide some of the best archaeological evidence for Middle Archaic era human occupation on the Delmarva Peninsula. Numerous other sites from this period have been found along the eroded shorelines and in ploughed fields of the region (Lowery 1999 and Custer 1986). The large number of archaeological sites associated with the early-middle Holocene seems to indicate continued regional population growth.

Secondary cobble sources found locally were almost exclusively used to make stone tools. Even so, exotic non-local rhyolite has been found in Middle Archaic era assemblages (Custer 1986). Large numbers of Middle Archaic era Kirk stemmed points are manufactured from banded rhyolite. The presence of non-

local lithic materials at Delmarva Middle Archaic sites may point towards the establishment of trade and exchange networks, while the heavy reliance on local lithic resources may indicate more localized Middle Archaic-era territories with restricted mobility patterns.

A typical early Middle Archaic tool kit would include small bifurcated projectile points, large bifurcated knives, as well as adzes, crude chopping tools, flake tools, and scrapers made from debitage detached from small bi-polar pebble cores. The latter portion of the Middle Archaic period is marked by the appearance of a stone tool kit that includes stemmed projectile points, large hafted knives, flaked ulu knives, utilized flakes, egg-shaped bola stones, and a complex ground stone tool assemblage, which includes adzes, full channel-grooved gouges, and crescent-shaped bannerstones or spearthrower weights.

The beginning of the Middle Archaic period is closely linked to the beginning of the "Hypsithermal" climatic event. Some researchers have referred to this era as the "Delmarva Desert" period (Millis et al. 2000). The warming episode associated with the beginning of the Holocene continued and may have created drought-like conditions on the Delmarva Peninsula (Kellogg and Custer 1994; McWeeny and Kellogg 2001). Dune building and sand reworking activity during the early-middle Holocene may have been limited to localized, dry, denuded landscapes susceptible to wind activity or in areas where large quantities of parent sand material were readily exposed to wind erosion.

Within the Delmarva area, there are large numbers of Middle Archaic sites found in agriculturally tilled fields regardless of the particle-size associated with the parent soil type. These observations may signify that few intact or buried Middle Archaic sites have survived the ravages of time. Even so, large areas along what was the developing Atlantic coastline during the Middle Archaic period may contain buried archaeological components. As sea levels rose along the Atlantic coast, onshore eolian processes combined with the droughts, may have stimulated the migration of dunes farther inland. This may signal that Middle Archaic-era human occupation sites along the Atlantic coast of Delmarva may be more deeply buried or stratified.

During the early portions of the Middle Archaic period, around 9,900 years BP, sea level was approximately 33 meters (108 feet) lower than present. Around 8,200 years ago, relative sea levels in the Middle Atlantic were approximately 20 meters (66 feet) below current levels. At the terminus of the Middle Archaic period around 6,500 years ago, relative sea levels were approximately 12.5 meters (41 feet) lower than present (Stright 1995). Clearly, the Middle Archaic period was a time of relatively rapid sea level rise and ecological change in the Chesapeake Bay drainage.

Virtually all of the Middle Archaic sites on the Delmarva Peninsula are currently situated in terrestrial areas that were upland interior settings between 10,000 and 6,800 years ago. The settlement patterns and the types of focal points for human occupation within the Delmarva coastal plain over this period are again highly biased, as sea level rise has prevented us from gaining easy access to

archaeological settings that, in the early-middle Holocene, were major floodplains, major river confluence points, and coastal environments. However, some late Middle Archaic-era cemeteries have been discovered in inundated contexts situated near drowned river confluence areas which provide us with rare glimpses into the life of these early cultures (Lowery 2003c).

Models that have been proposed for Middle Archaic settlement patterns and demography in this area (Custer 1990; Parker 1990) also suffer from the limitations of sea level rise. As indicated earlier, we do know that shellfish resources were available to the Middle Archaic cultures living within the developing Chesapeake Bay (Cronin 2000), but we cannot be certain that people took advantage of them. The archaeological procurement settings for shellfish and marine resources are now for the most part inundated and difficult to access.

Late Archaic and Terminal Archaic Periods (6,500 – 3,000 Cal. Yr. BP)

Numerous Late Archaic era sites have been found in Delmarva (Custer 1989, Dent 1995, Reinhart and Hodges 1991), and models for settlement patterns and demography have been proposed for parts of the region (Reinhart and Hodges 1991). The large number of archaeological sites associated with this period signifies a large regional population.

Like the Middle Archaic period, stone tools and projectile points were generally made primarily from materials found in local, secondary deposits of cobble. In addition to ground and polished gouges, grooved axes and adzes occur during the Late Archaic period and were used to cut wood, fell trees, and craft dug-out canoes. Non-local materials, such as rhyolite and argillite, are also found at most Late Archaic-era sites (Custer 1989). More importantly, caches of large stemmed and unstemmed bifaces have been found at some Archaic-era sites. Caches of rhyolite bifaces are common on the western side of the Delmarva Peninsula, whereas, caches of argillite bifaces are far more common on the eastern side of the peninsula. The distribution of cached lithic materials may reflect the relative proximity of portions of the peninsula to the parent lithic quarries.

Other exotic lithic materials seem to have been traded into the peninsula during the Late Archaic period. Porphyry, a non-local hard igneous rock with large crystals of feldspar or quartz, was used to manufacture some notched crescent-winged bannerstones or spearthrower weights and a few grooved axes found at sites on the Delmarva Peninsula. Exotic banded slate and steatite were also used to manufacture some bannerstones. Steatite was also used to manufacture stone bowls during terminal phases of Delmarva's Late Archaic period. The presence of non-local lithic materials suggests that the local cultures had developed trade and exchange networks. The caches at specific sites would imply that these cultures periodically reused certain areas.

Probably the most unreported aspect of the Late Archaic period in this area is the cultural influence from peoples living outside the region. Contact, whether direct or indirect, from cultures occupying the eastern Great Lakes area are

indicated by the presence of ground slate knives, ground slate points, and stone gouges (Lowery 2003c). Long-distance trade and exchange with the Laurentian Archaic peoples also is suggested by the presence of a few exotic hammered copper points, crescent knives, adzes, and fishhooks found at a limited number of sites on the Delmarva Peninsula (ibid). These utilitarian copper artifacts are identical to “Old Copper” culture tool types found in the western Great Lakes area. The types and styles of copper artifacts found in the region found with a burial near Still Pond, Maryland were probably manufacture by people associated with the western Great Lakes “Old Copper” culture and traded to the Laurentian Archaic cultures living in the eastern Great Lakes area. Based on the presence of “Old Copper” culture items within the Laurentian assemblages in the northeast, the few exotic copper artifacts found locally almost certainly reached the Delmarva area via the Late Archaic Laurentian cultures living in Quebec, Ontario, and New York (Chapdelaine et al. 2001:102-110). It seems clear that these exotic items are the result of long-distance trade and exchange with cultures far removed from the Delmarva area. The local scarcity of Late Archaic copper items indicates that a long-distance “down-the-line” trade pattern had been established at least by 5,000 years ago. The question arises as to what local Delmarva commodity was being traded outside the region and ultimately ending up with the cultures living in the western Great Lakes area? At the Oconto site, an “Old Copper” culture cemetery in Wisconsin, Ritzenthaler and Wittry (1952: 199-223) have reported two whelk shell fragments from a 5,000 year old grave. Maybe whelk shell was the commodity being traded from the Middle Atlantic region to cultures outside the region 5,000 years ago. The limited amount of marine shell found at a few of the western Great Lakes “Old Copper” culture sites would also suggest a long-distance “down-the-line” trade pattern had been established.

The Late Archaic period is marked by a series of climatic changes that suggests warm and wet conditions initially, changing to warm and dry conditions, and finally ending with wet and colder conditions (Kellogg and Custer 1994, McWeeny and Kellogg 2001, Fiedel 2001, and Custer and Watson 1987). Within the larger Delmarva area, there are large numbers of Late Archaic sites found in agriculturally disturbed fields, regardless of the parent soil type. Stright (1995) has observed marked sea level changes during the Archaic period that can be linked to continued Holocene warming. Relative sea level circa 6,500 years BP was approximately 12.5 meters (41 feet) lower than present. Around 4,000 years ago, sea level in the Chesapeake Bay was about 6 meters (19.5 feet) lower and by the end of the Late Archaic period circa 3,000 years BP, sea level had risen to approximately 3.2 meters (10 feet) lower than present.

Observations from agricultural fields indicate that only a limited number of intact or buried Late Archaic sites are present in the tilled interior upland areas of the modern Delmarva Peninsula. Given the sea level history, some Late Archaic era estuarine resource procurement sites may be buried below tidal marsh deposits in inundated upland settings. Current archaeological data indicates that the region’s Late Archaic peoples were exploiting estuarine and

marine resources (Custer and Lowery, n.d.). Along the Atlantic seaboard, transgressive barrier island processes may prove that some of the Atlantic coastal sites are offshore or buried below coastal dune formations.

Early Woodland Period (3,000 – 2,500 Cal. Yr. BP)

During the transition from the Archaic period to the Woodland period, regional cultures experimented with early ceramic technologies in tandem with the use of earlier stone bowls. Fishtailed knives and projectile points are diagnostic of this Terminal Archaic-era along with experimental ceramics with shapes similar to the earlier steatite bowls.

The Early Woodland period is marked by the complete adoption and use of ceramic technology and ceramic vessels as part of a daily lifestyle. Only a limited number of Early Woodland era sites have been found along the eroded shorelines and within the ploughed fields of Delmarva (Custer 1989; Dent 1995; Reinhart and Hodges 1991), and researchers (see Fiedel 2001) have tried to address the paucity of Early Woodland sites. Some researchers have suggested that the smaller number of sites is suggestive of a smaller regional population. Others have proposed that the lack of “good” diagnostic stone tools might explain the lower number of recognized sites. Whatever the reason, we know that local secondary cobble sources were still extensively used to make stone tools, but non-local materials such as rhyolite and argillite were also utilized (Custer 1989).

Aside from rhyolite and argillite, other non-local lithic materials were also entering the region. Completed artifacts made of varieties of exotic lithics originating from the Great Lakes region, western New York, and the Ohio Valley drainage are found at some Early Woodland sites on the Delmarva Peninsula. Usually, the exotic items are associated with Early Woodland mortuary features, but they are occasionally found at habitation sites. Styles of artifacts, such as birdstones, have been found on the Delmarva Peninsula. Outside of the region birdstones are usually associated with “Glacial Kame” and “Meadowood” cultures (Converse 1979; Townsend 1959). A few “turkey-tail” blades have also been found on the Delmarva Peninsula made of Wyandotte Chert from Indiana. These “turkey-tail” points are linked to the “Red Ochre” culture (Converse 1979; Ritzenthaler and Quimby 1962) of that region.

The “Glacial Kame” and “Red Ochre” style items found on the Delmarva Peninsula may have arrived here via the Meadowood culture trade network (Granger 1978). This network can be linked to the peoples living in western New York circa 2,500 to 3,000 years ago. The trade pattern linking the Delmarva area to the cultures living in western New York developed during the Late Archaic period and continued into the Early Woodland period. One of the hallmarks of the Meadowood culture is the style of projectile points and cache blades. Meadowood type points and cache blades made of Onondaga chert from New York and Ontario and burials dating to roughly 2,700 years BP (Bastian 1975) have been found on the Delmarva Peninsula with caches of copper beads.

During the latter portion of the Early Woodland period, items associated with the Ohio Valley Adena mound-building culture begin to appear in the archaeological record of the Chesapeake Bay area (Custer 1989; Dent 1995; Ford 1976). The Meadowood-era trade seems to have been focused along the Susquehanna and Delaware River systems, whereas the Adena-era trade seems to have shifted towards movement along the Potomac River system. Based on the distribution of Meadowood items on the Delmarva Peninsula and the relatively “pure” nature of the associated site assemblages, Lowery (2007) has argued that the Meadowood presence on the Delmarva Peninsula represents direct acquisition of items for trade and exchange. It is suggested that during the latter portion of the Early Woodland period direct acquisition breaks down and there is more focused exchange between cultures living in the Ohio Valley and contemporaneous cultures living on the Delmarva Peninsula. This assumption is based largely on comparing the observed Meadowood pattern at sites with characteristics seen at sites having later Adena artifacts mixed with “impure” local traits. Trade in Atlantic coast marine shell may explain the presence of exotic non-local items on the Delmarva Peninsula during the Early Woodland period (Ritchie 1969:196).

The climate of the Early Woodland period is marked by wet and colder conditions (Kellogg and Custer 1994). Sea level circa 3,000 years BP was approximately 3.2 meters (10 feet) lower than present, and by the end of the Early Woodland period, circa 2,500 years BP, sea level had risen to approximately 2.3 meters (7.5 feet) lower than present. Since Early Woodland sites are predominantly found in disturbed agricultural field contexts, only a limited number of intact or buried Early Woodland sites may have survived within the interior upland areas of the modern Delmarva Peninsula due to the historic anthropogenic tilling. Given the sea level history, a large number of Early Woodland-era estuarine oriented prehistoric occupation sites may be buried below tidal marsh deposits or offshore in inundated upland settings. Along the Atlantic seaboard, transgressive barrier island processes may have buried some of the Atlantic coastal sites below coastal dune formations.

Middle Woodland Period (2,500 – 1,000 Cal. Yr. BP)

Numerous Middle Woodland era sites have been found on Delmarva (Custer 1989; Dent 1995; Reinhart and Hodges 1992), and the density of sites may indicate an increase in regional populations or an intensive focus of occupation in the coastal environments. In contrast, certain areas of the Middle Atlantic seem to be absent of a human presence or occupation. As such, the coastal areas may have been a focal point for human settlement between 2,000 and 1,000 years ago.

With respect to stone tool kits, secondary cobble sources found locally were only occasionally used to make stone tools during the Middle Woodland period. Non-local materials, such as rhyolite and argillite, are the most predominant lithic material present at most Middle Woodland-era sites (Custer 1989). Pennsylvania jasper, Normanskill chert, and Upper Mercer chert, which are also non-local lithic materials, are found at most large Middle Woodland-era Fox

Creek sites. The most common Middle Woodland period diagnostic artifacts include the Fox Creek point, large Petalas blades, and shell-tempered Mockley ceramics; the latter being a pottery style that emerged during this period.

Along some watersheds draining into the Chesapeake (i.e., the Miles River, the Choptank River, and the Little Choptank River), numerous caches of large Petalas bifaces have been discovered (Custer 1987). Large, exotic stone artifacts from the Ohio Valley area are present in some early Delmarva Middle Woodland mortuary features, and these have traditionally been associated with the "Delmarva Adena Complex." However, projectile point, copper breastplates, channel coal pseudo-bifaces, Hopewellian-style blades, copper celts, and other exotic artifacts have been found on the Delmarva Peninsula that would logically be more suggestive of "Hopewellian" contacts from the Ohio Valley than the traditionally accepted late Adena links (Lowery 2003c).

Along the Atlantic seashore in Virginia, Lowery (2003b) has recovered "Hopewellian" style points made of Ohio Valley cherts, rhyolite Fox Creek points, a copper celt, marine shell beads, and small stone drills in association with an organic midden deposit that contains fish remains, shell-tempered Mockley ceramics, and bone fishhooks. Interestingly, at the Frederica cemetery site in Delaware, exotic Hopewellian artifacts were found in association with local rhyolite Fox Creek points and blades (Lowery 2003c). A radiometric date on the Frederica materials indicates a range of A.D. 391 to A.D. 531 (Custer et al. 1990), which would be too young for the Ohio Valley Adena culture, but would overlap with the last phases of the Hopewell culture. Trade in Atlantic coast marine shell and fossil shark teeth from geologic deposits along the shore of the Chesapeake Bay may explain the presence of exotic Hopewellian items on the Delmarva Peninsula during the early portion of the Middle Woodland period. The immense distances involved in this Middle Woodland-era trade network are clearly evident at the Frederica site. A large stemmed biface made of Knife River chalcedony, which outcrops in North Dakota, was found at this site along with a similarly large stemmed biface made of Novaculite, which originated in Arkansas.

During the latter portion of the Middle Woodland period, Kipp Island, Webb Phase, or Intrusive Mound-like materials appear in the archaeological record of the Delmarva Peninsula (ibid). These outside influences originated from the eastern Great Lakes region, the New England province, and the Ohio Valley region. Large Kipp Island or Webb Phase cemetery sites and massive habitation sites have been found along parts of Delmarva's Atlantic coast and within the middle Chesapeake Bay section of Maryland's Eastern Shore.

The coastal habitation sites on Delmarva include assemblages of Jack Reef type projectile points, mica and sand tempered ceramics, along with a variety of bone tools. Interestingly, some of the lithic materials used to make a few of the Jack's Reef points found locally were quarried from outcrops in Ramah Bay, Labrador, which is over two thousand miles north of the Delmarva Peninsula near the Arctic circle. A truly massive Ramah quartzite pentagonal biface from the Labrador quarries was found at the Riverton site (Loring 2002:180), along the

Nanticoke River in Wicomico County, Maryland. The Ramah quartzite biface from Riverton was found in association with Jacks Reef corner-notched and un-notched points, as well as, numerous exotic stone platform pipes.

Delmarva's Kipp Island, Webb Phase, or Intrusive Mound-like sites suggest something more than simple trade and exchange. Custer et al. (1990) believe that the Kipp Island or Intrusive Mound-like materials found associated with Delmarva's Webb phase indicate an actual migration of people into the area. There may be some local data that lends credence to this idea. At contemporaneous sites in Maine, Bourque (2001:89-94) notes a marked increase in exotic materials from Ramah Bay associated with a corner-notch point type that is more commonly found at late prehistoric sites in Newfoundland and Labrador. Aside from the Ramah quartzite biface from the Riverton site, a small walrus ivory adze found a Webb Phase site along the Honga River in Dorchester County, Maryland also hints towards a northern intrusion into the area. Whether this intrusion was from the far northeast or from the direction of the Great Lakes is up for debate.

During the entire Middle Woodland period, there is evidence of intensive use of estuarine and marine resources. Large shell middens with oyster, soft-shell clam, razor clam, hard-shell clam, ribbed mussel, bay scallop, and whelk are found along the shorelines of the Delmarva. Some of the fish remains (i.e., bull shark and juvenile Great White shark) reported by Lowery (2003a, 2003b) from the Upper Ridge site may be associated with that site's Webb Phase component. Because of the stabilization of sea level during the Middle and Late Woodland periods, these circumstances may have provided a biased archaeological expression of intensive marine resource use by regional prehistoric peoples. The bias may simply be the result of the fact that more Middle and Late Woodland age terrestrial shoreline settings, which were used as fishing localities, have survived marine transgression.

The Middle Woodland period was marked by a climate with initially warm and wet conditions, changing to the warm and dry conditions associated with what some researchers have called the "Medieval Warm Period" (Cline et al. 2001; Millis et al. 2000). Within the larger Delmarva area, there are numerous Middle Woodland sites found in agriculturally disturbed tilled fields, appearing in all varieties of parent soil types (i.e., sand, silt, or loam). Sea level circa 2,000 years BP was approximately 2.3 meters (7.5 feet) lower than present. By the end of the Middle Woodland period circa 1,000 years BP, sea level had risen to approximately 1 meter (3.3 feet) lower than present. Given the sea level history, fewer Middle Woodland-era estuarine and marine oriented prehistoric occupation sites would be buried below tidal marsh deposits in inundated upland settings than in previous periods. Also along the Atlantic seaboard, transgressive barrier island processes may have buried some Atlantic coastal sites below coastal dune formations.

Several sites in the region (i.e., 18DO30, 18DO424, 44NH435, 44NH436, and 44NH437) indicate eolian dune formation and the subsequent burial of Middle Woodland and pre-Middle Woodland archaeological components along widely

separated sections of coastline adjacent to the Chesapeake Bay (Cline et al. 2001; Lowery 2001). These natural site burial processes may be associated with the warm and dry conditions of the "Medieval Warm Period." In some areas with copious amounts of parent sand material, drought conditions and intense winds likely resulted in natural dune formations that buried some archaeological sites. Even so, the unweathered nature of diagnostic rhyolite Middle Woodland artifacts observed in the region suggests that these materials were quickly covered after deposition, so eolian processes may have been more extensive and the natural burial processes may have impacted numerous regional archaeological sites.

Late Woodland Period (1000 - 400 Cal. Yr. BP)

Late Woodland era prehistoric settlements are, by far, the most common coastal sites on the Delmarva Peninsula (Custer 1989; Dent 1995; Reinhart and Hodges 1992). The increased density of sites over other time periods probably indicates an increase in regional populations, or perhaps an intensive focus of occupation in the coastal plain. One could also argue that the increased evidence of archaeological sites of this time period could also be a by-product of more stable coastlines with slower rates of sea level rise.

Late Woodland era stone tool kits are almost exclusively made from locally found cobbles that were collected from secondary geologic deposits. Stone triangular arrow points are made from cobbles of chert, jasper, quartz, and quartzite. Late Woodland assemblages also include highly decorated shell-tempered ceramics. The decorated ceramics may indicate a continued change in local ceramic technologies during this period. The lack of exotic or non-local lithic artifacts in Late Woodland assemblages suggests that the broad-based exchange networks of earlier periods were disrupted or severely attenuated (Stewart 1989, 1994:87-89). It has been suggested that trade in marine shell and soapstone pipes may have continued during the Late Woodland period (ibid). Aside from the triangular arrowheads and small utilized flakes commonly found at most Late Woodland sites, small ground stone celts or ungrooved axes are also present during the Late Woodland period. The meaning behind the transition from the larger wood working tools, common during the Late Archaic period through most of the Middle Woodland period, to the much smaller stone axe is not clear.

Many models for Late Woodland era settlement patterns and demography have been proposed for sections of the Middle Atlantic region (Reinhart and Hodges 1992). Late Woodland era sites vary in size depending on the setting and, like other Woodland era sites, produce obvious sub-surface features (Custer 1989). Late Woodland cultures on the Delmarva seem to have practiced a wide variety of subsistence strategies and seem to have had diverse patterns of social organization. There is virtually no evidence of agriculture on Maryland's eastern shore during this period. Research at the Holland Point site in coastal Dorchester County, Maryland (Walker 2002), for example, revealed no evidence for the use of cultigens. Meanwhile, the peoples living on the Virginia section of the

Delmarva seem to have practiced an agricultural lifestyle (Rountree and Davidson 1997). Custer (1989) indicates only a limited use of cultigens for the Late Woodland peoples living in Delaware.

Based on the preserved remains from refuse features, hunted and gathered resources, such as deer, nuts, seeds, and berries, seem to have provided the bulk subsistence stores. For most of the Delmarva Peninsula during the Late Woodland period, there is evidence of intensive use of estuarine and marine resources. Large shell middens with oyster, soft-shell clam, razor clam, hard-shell clam, ribbed mussel, bay scallop, and whelk are found along the shorelines of the peninsula. The stabilization of sea level rise during the Late Woodland period may have resulted in a larger, more evident archaeological expression of regional marine resource use in modern terrestrial settings.

The Late Woodland period is marked by a climatic transition from the warm and dry conditions associated with the "Medieval Warm Period", circa 1,200 to 800 calendar years ago, to an era of colder winter temperatures associated with the "Little Ice Age", circa 600 to 150 calendar years ago (Cline et al. 2001; Kutzbach and Webb 2001; Millis et al. 2000). Periods of protracted droughts have also been reported for the latter portion of the Late Woodland period (Stahle et al. 1998). Brush (2001) has reported evidence of extensive fires and possible forest burning events during the Late Woodland period. These fires may have been the result of cultural burning episodes. Numerous burned and presently inundated upland forests have been observed beneath a mantel of tidal marsh deposits in Dorchester and Somerset counties, Maryland and in Accomack County, Virginia.

Sea level circa 1,000 years BP was approximately 1 meters (3.3 feet) lower than present. By the end of the Late Woodland period circa 500 years BP, sea level had risen to approximately 0.4 meters (1.3 feet) lower than present. Over the past 500 years, a limited amount of sea level rise combine with shoreline erosion has further sculpted the overall outline and shape of the bay. In areas subjected to drought conditions, impacted by intense winds, and associated with copious amounts of parent sand material, the eolian dune development may have continued. Given the sea level history, only a few of Late Woodland sites originally situated along coastlines would have been buried below tidal marsh deposits in inundated upland settings. However, shoreline erosion may have played a major role in destroying many Late Woodland sites in coastal areas. From circa 2,000 years ago to present relatively stabilized sea levels in and around the Chesapeake Bay may have resulted in many bay front archaeological sites being lost to shoreline erosion. The relative scarcity of Late Woodland settlements situated along the modern Atlantic seaboard may imply that some of the Atlantic coastal sites were buried below coastal dune formations as a result of natural transgressive barrier island processes.

Contact Period (400 - 300 Cal. Yr. BP)

Only a few Contact era sites have been found in Delmarva (Custer 1989; Dent 1995; Reinhart and Hodges 1992; Rountree and Davidson 1997). The lack of sites may simply be an indication of the smaller unit of time associated with this era.

Even so, records suggest that diseases introduced by the first European explorers may have decimated the Native population. Access to trade goods, along with the displacement of native groups, the establishment of the reservation system, as well as warfare and conflict characterized this period. On Maryland's Eastern Shore, a reliance on agricultural goods developed as a subsistence base for the first time. The reason for the late adoption of agriculture seems to have been the confinement of Native peoples to smaller tracts of land, which was a result of the reservation system. As during the Late Woodland period, local, secondary cobble sources were almost exclusively used to make stone tools during the early part of the Contact period. Stone triangular points and Townsend-style ceramic technologies continued during Contact period. However, Contact period assemblages are distinguished by the inclusion of European metal goods (i.e., guns, knives, and hoes), cut fragments of copper and brass, cut copper and brass triangular projectile points, clay smoking pipes, European ceramics, and glass trade beads.

The Contact period is marked climatically by colder winter temperatures associated with the "Little Ice Age", circa 600 to 150 calendar years ago (Cline et al. 2001; Kutzbach and Webb 2001; Millis et al. 2000). Sea levels had stabilized by this time and were essentially the same as today or only slightly lower, and the marine resources available in the Chesapeake Bay were obviously more abundant than today. Early accounts (Wharton 1973) indicate that large reefs of oysters, abundant fish species, sea turtles, and seals occupied portions of the Chesapeake ecosystem. Aside from deer, the terrestrial landscape included a variety of regionally extirpated species, including elk, puma, bobcats, wolves, and possibly bison. Species of trees that are no longer present in large numbers, such as the American chestnut and American elm, would have been part of Delmarva's forest ecosystem.

With respect to the Native cultures that once occupied the Delmarva Peninsula, their lifestyle dramatically changed. The 16th century John White paintings portray a proud people who had adapted to the region over a period that spanned many millennia. With the colonization of the region by the English in the early 17th century, the prehistory of the Chesapeake Bay would end and the lifestyles of its native inhabitants would be dramatically altered. The coastal hunting and gathering lifestyle illustrated by John White in 1585 survives only in the archaeological record. Even today, clues about these ancient prehistoric cultures and their environment lie buried underfoot and exposed along eroded shorelines adjacent to the Chesapeake Bay and its tributaries. The features, objects, artifacts, and debris created, discarded, buried, and coveted by these early natives are the most tangible clues about the lifeways associated with the prehistoric cultures of the Delmarva Peninsula. Even though this type of research is largely ignored, these cultural objects and features can also provide very important data about environmental and ecological change.

Historical Background

European discovery of the Delaware Bay occurred in 1609 when Henry Hudson surveyed the northeast coast of North America for the Dutch East India Company. While Hudson's investigation failed to locate a safe northwest passage to the Orient, his observations stimulated interest in additional exploration, trade, and colonization (Weslager 1961:29-34). In 1614, the State General of Holland granted the merchants of Amsterdam and Hoorn exclusive privileges to trade between 40 and 45 degrees of latitude in an area identified as the territory "New Netherland." The first Dutch explorers came to the Delaware Bay from New Amsterdam (New York City) in October 1614. By decree from The Hague, dated October 11, 1614, the owners of five Dutch ships were authorized to establish the United Company of Merchants with exclusive rights to explore the area between New France in the north and Virginia to the south. Using charts prepared by the captains of United Company of Merchants' vessels, Captain Cornelius Hendrickson located and explored the bay aboard the *Onrust* (Restless). Captain Hendrickson produced the first chart of the Delaware Bay and river in 1616. In a brief report submitted to the Dutch merchants, the explorer claimed to have found "certain lands, a bay and three rivers situated between 38 and 40 degrees" (Weslager 1961:45).

The Dutch and Swedes were responsible for early exploration of the Delaware Bay. Dutch exploration of the bay soon led to the establishment of trading stations and settlements. In 1623, the Dutch East India Company constructed a fortification on the east shore of the bay. In that same year, colonists arrived in the *Nieu Nederlandt* to settle in the vicinity of the fortification or perhaps further upstream on Burlington Island. Seven years after Fort Nassau was established on the east shore, the ship *Walvis* departed with colonists to establish a second settlement. The expedition arrived in the vicinity of present Lewes, Delaware, in 1631 with supplies for farming and whaling. The Dutch and Swedes were responsible for the exploration of the bay. They established a settlement called Zwaanendael or "Valley of Swans" that was completely destroyed by Indians in 1632 (Munroe 1978:2-12).

The Dutch shared the Delaware with Swedish explorers, traders, and settlers. In 1629, the Swedish West Indian Company purchased from the Indians the tract of land on the west side of the Delaware Bay. Extending from Cape Henlopen north 32 miles to a point slightly above present Bowers Beach and extending approximately 2 miles inland, the tract provided sufficient land for trading settlements. Although the purchase was ratified in 1630, it was not until Peter Minuit arrived with an expedition in 1638 that the Swedish attempted to initiate a settlement (Hazard 1850:16). Ignoring the deeded tract purchased from the Indians, Minuit's colonists proceeded upriver to a more suitable landing site on the west shore, near present Wilmington, Delaware. There, they quickly built Fort Christina to protect their interests.

Under the direction of Peter Stuyvesant, the Dutch responded to Swedish threats to their trade by constructing additional fortified trading stations. In 1655, Fort Beversreede was constructed on the Schuylkill. When the Swedes opened a trading station in the shadow of the fort, Stuyvesant organized a massive show of force, abandoned Fort Nassau and Fort Beversreede and constructed a larger fortification, Fort Casimir, at the site of present New Castle, Delaware, and formed the settlement of New Amstel. This community flourished, in spite of sporadic hostilities with the Swedes, until the British assumed control of the Delaware Valley in 1664 (Weslager 1961:105-158; Munroe 1978:30-57).

When King Charles II made a grant of lands in the Delaware Valley to his brother James, Duke of York, the Duke sent a flotilla of warships under the direction of Sir Robert Carr to capture Fort Casimir, subjugate the Dutch and Swedes and to institute British control in the Delaware region. In October 1664, Sir Robert Carr captured New Amstel from the Dutch and renamed the settlement New Castle. With the exception of a brief period in 1673, when the Dutch attempted to reoccupy the Delaware, the entire area was governed as a part of New York (Munroe 1979:30-31). After years of limited interest on the part of the Duke of York, King Charles II deeded a substantial portion of the territory to William Penn in 1682. Penn subsequently established an English colony on the Delaware with Philadelphia as its capital (Weslager 1967:176-201).

As the original Pennsylvania grant did not include lands with ready access to the Ocean, Penn secured agreements with the Duke of York for control of his property along the western perimeter of the Delaware Bay. Upon his arrival in New Castle, Penn created Kent and Sussex counties in addition to New Castle County. Although his title to the area was contested by Lord Baltimore, Penn was able to maintain his claims through political influence until religion and colonial politics combined to separate Pennsylvania and Delaware at the turn of the eighteenth century (Munroe 1979:37-38). In 1704, Governor Evans consented to a separate Assembly, which met in New Castle. Until the Revolutionary War the Delaware counties were governed as a proprietary colony, although the British Crown never entirely relinquished its claim (Munroe 1978:103-116).

During the eighteenth century the population of the Delaware counties increased rapidly. Wilmington, a new settlement on the Christina River, was chartered in 1739 and developed to replace New Castle as the major center of trade (Farris 1970:22-51). This commercial center was supported by a rapidly expanding agrarian population that developed in the interior. Immigrants arrived in increasing numbers from as close as Maryland and as far away as Scotland and Ireland. Large plantations and small farms produced tobacco and a variety of staple crops, vegetables, and fruit. In Sussex County, timber resources created a thriving trade in lumber. Along the bay, abundant fish and oysters supported small-scale maritime industries (Miller 1971:240). Philadelphia remained an important commercial, social, and political factor in Delaware's development. By 1772 that city had become the busiest port in North America (Cox 1985:33).

Although development was disrupted by the Revolutionary War, political and military activity increased. Delaware selected and dispatched representatives to the Continental Congress. On 15 June 1776, the assembly meeting at New Castle voted to sever relations with the Crown. The convention also adopted a constitution, giving the lower counties the title "The Delaware State". Revolution brought military conflict in 1777. While General Howe's invasion of the state and occupation of Philadelphia was short-lived, the British threat to Delaware Bay commerce continued throughout the Revolution (Munroe 1954:80-94). That threat returned during the War of 1812 and a British squadron briefly threatened Lewes with destruction in March 1813 (Munroe 1954:258).

Prior to the American Civil War, Delaware changed rapidly. Manufacturing, a pursuit secondary to agriculture in the previous century, flourished. While gristmills remained as the most important industry, forges in Sussex and New Castle counties became major producers of iron. Textile, paper and gunpowder mills were placed in operation during the first quarter of the nineteenth century. Industrial production was facilitated by maritime commerce and the development of roads and later railroads and steam navigation (Wolfe 1970:98-110). By the American Civil War, Delaware offered a well-rounded combination of agricultural, industrial, and maritime commercial interests (Munroe 1979:103-110; Miller 1971:242-243). During that conflict, Delaware provided both military personnel and industrial products. More than one-third of the gunpowder produced by the Union came from Delaware mills (Munroe 1979:138).

In post-bellum Delaware, industrial development that began in the early nineteenth century continued and expanded into the twentieth century. Although urban development changed much of northern Delaware, agricultural and maritime activities survived in the south and a variety of fish, fruit, and vegetable products continued to be produced for markets in the urban corridor. Late in the nineteenth century, steam navigation on the bay brought increasing numbers of urban dwellers to resorts.

Rehoboth Beach Historical Background

Rehoboth Bay was used for a number of its natural resources. Richard Allen, a freed slave, carted salt from a salt works at Rehoboth in the late 18th century (Munroe 1978:194). Highly valued, oysters were found along the shores of Rehoboth Bay as early as 1662 (Scharf 1888:1215). They were so numerous, it was reported that "one man in a day could take thirty bushels" (Munroe 1978:198). However, due to the difficulty in reaching the area, the locale remained largely unsettled and undeveloped.

The Rehoboth Association was incorporated on 15 March 1871 and several hundred acres were purchased the following year with the goal of establishing a religious resort (Scharf 1888:1219). Rehoboth Beach was initially established as "The Rehoboth Beach Camp Meeting Association of the Methodist Episcopal Church" by Reverend Robert W. Todd on 27 January 1873 and a camp meeting ground was set up in a grove half a mile from the beach (Rehoboth Beach Delaware n.d.; Scharf 1888:1219). A number of spacious lots were sold at fifty

dollars. Two hotels were built, the Surf House and the Bright House, along with a number of cottages. In addition to the hotels and cottages, a post office was established in 1873. Dr. William Dawson, the postmaster, also owned a drug store, which was the first business located on the beach.

In 1878, the Rehoboth Beach Life-Saving Station was commissioned (Figure 3) (Hurley and Hurley 1984:120). While the number of reported wrecks on Rehoboth Beach was minimal, the station aided Cape Henlopen station to conduct rescues on the cape. Three men served as keepers of the Rehoboth Beach Life-Saving Station between 1878 and 1914: Thomas Truxton, Thomas W. Steel, and Fred G. Vogel.



Figure 3. Rehoboth Beach Life-Saving Station ca. 1885 (Hurley and Hurley 1984:121).

Initially, Rehoboth Beach could only be reached by stage or private boat. In 1879, a railroad was established that reached the camp meeting grounds on the outskirts of the town (Scharf 1888:1219; Conrad 1908:719). The railroad allowed travelers to visit the beach, driving the growth of the small town. In addition, the steamer *John Sylvester* made trips between Philadelphia, Lewes and Rehoboth (*Chester Daily Times* 1879:3). By 1884, the railroad was extended eastward on the main road through Rehoboth Beach and a depot was built in a central location (*Denton Journal* 1883:2).

In 1879, the “The Rehoboth Beach Camp Meeting Association of the Methodist Episcopal Church” was changed to “Rehoboth Beach Association” and by 1881 camp meetings were terminated (Scharf 1888:1219). In 1884, a 1.25-mile long boardwalk was built along the beach. The beach was described as “firm and smooth, and owing to its regularity is deemed very safe” (Scharf 1888:1219). In 1891, the name was changed to “Cape Henlopen City” (Rehoboth Beach Delaware n.d.). The town continued to grow and in the following year, the first policeman was employed. In 1893, the name was again changed to “Rehoboth” and the town hired its first lifeguard. Horn’s Pavilion, an emporium built on a pier by Charles Horn, was constructed in 1903 and reached 150 feet into the ocean. A strong storm in 1914 destroyed the pier, the boardwalk, Surf Avenue, and a number of beachfront cottages (Delaware Federal Writers’ Project 1976:255).

In April 1918, three barges pulled by a tug boat, left New York City for Norfolk, Virginia (George 2010:87-89). Near the Delaware capes, the vessels encountered heavy weather and an attempt was made to head for the Delaware Breakwater. However, the tug drifted too far south and the barges *Merrimac* (b. 1906) and *Severn* were cut loose from the tug to anchor. Neither barge could find an anchorage and slowly drifted toward Rehoboth Beach. The *Merrimac* went ashore near the foot of Brooklyn Avenue; the *Severn* not far away (Figure 4). While a tug managed to pull the *Severn* off the beach, the *Merrimac* was too damaged to save. Salvors recovered all but the hull. Due to the danger to swimmers, the town posted signs and swimming was prohibited in this area.

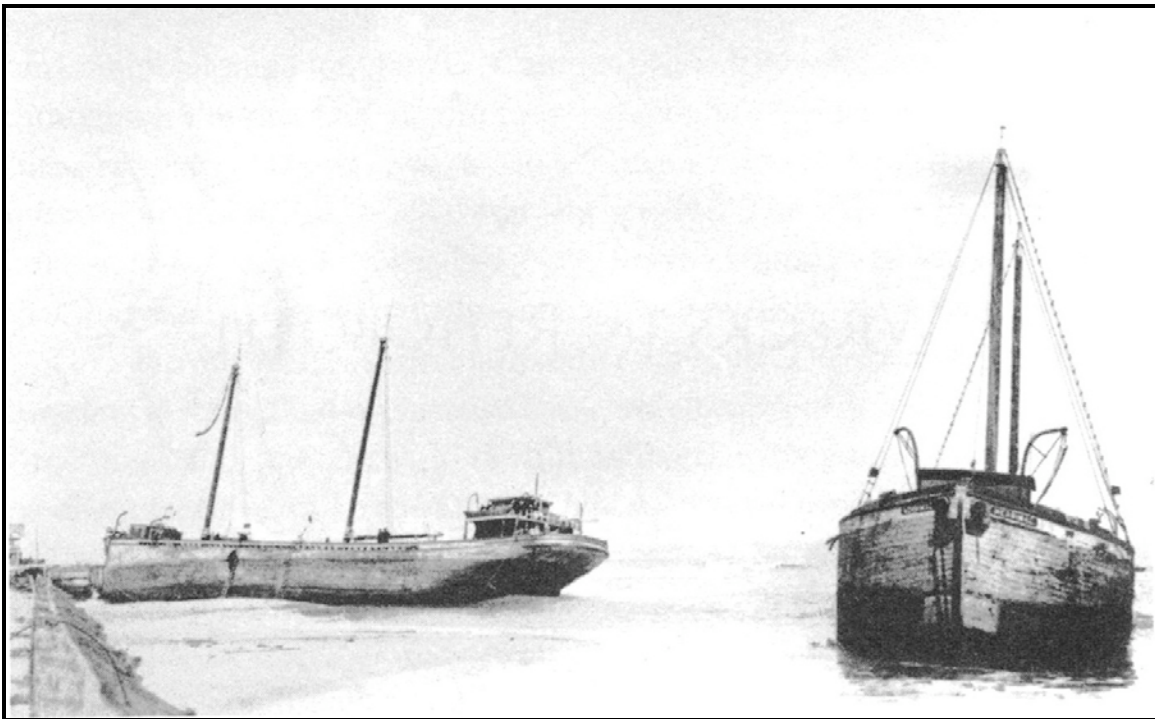


Figure 4. The *Merrimac* and *Severn* aground at Rehoboth Beach (George 2010:88).

By the 1920s, the Coleman du Pont Boulevard (US 113) extended down the state, a drawbridge was built over the Lewes-Rehoboth Canal, and passenger traffic on the railroad dwindled until it ceased in 1928 (Delaware Federal Writers' Project 1976:258; Rehoboth Beach Delaware n.d.). Efforts to control the mosquito population, which flourished due the proximity of a marsh, began in 1909, but were successful primarily with the aid of the Civilian Conservation Corps after 1933. In 1937, the name was changed for the final time to "City of Rehoboth Beach" and the first city manager was employed (Rehoboth Beach Delaware n.d.).

A week after the attack on Pearl Harbor forced the United States into World War II, the Delaware wing of the Civil Air Patrol was established (Morgan 2004:188). A base was established at Rehoboth Beach and was constructed from donated lumber. Members purchased their own uniforms and supplied equipment to keep their airplanes flying. These aircraft would fly over convoys to spot submarines. When a submarine was spotted, a B-25 would be dispatched from Dover. The B-25s often arrived at the location long after the submarine submerged. After 1942, these planes were equipped with small depth charges and bombs. In order to protect the coastline, a number of cylindrical fire-control towers, assigned to Fort Miles, were also constructed along the beaches of Delaware and New Jersey (Grayson 2005). The goal of these towers was to spot enemy vessels and to help advise gunners firing the 32 coast artillery pieces.

Rehoboth Beach's most famous wreck was caused, not by German U-boats, but by nature (George 2010:90-93). The 250-foot Coast Guard freighter *Thomas Tracy* (b. 1916) was heading south from New England when it encountered the Great Atlantic Hurricane of 1944. High winds and heavy seas pushed the *Tracy* ashore, right on top the *Merrimac*, and broke the ship in two parts. Due to the efforts of citizens and the Coast Guard, all the men on board the *Tracy* made it safely to shore. After the storm, wreckers cut the ship down to the waterline, but due to safety concerns, swimming is still prohibited in that area.

Folk singer Burl Ives's \$100,000 yacht, the *Black Spoonbill*, ran aground on Rehoboth Beach during a storm on 6 October 1957 (George 2010:89). The six-man crew was rescued by the Coast Guard. Two crew members sustained injuries and were taken to a hospital. However, the 62-foot auxiliary ketch was eventually pulled off the beach (Figure 6).

When the Chesapeake Bay Bridge opened in 1952, the number of visitors to Rehoboth Beach greatly increased (Thomas 1987). Today, the beach is Rehoboth's main attraction. The city hosts a number of additional forms of entertainment: outdoor concerts, the boardwalk, snack bars, restaurants, video game parlors, miniature golf courses, and the amusement park "Funland".

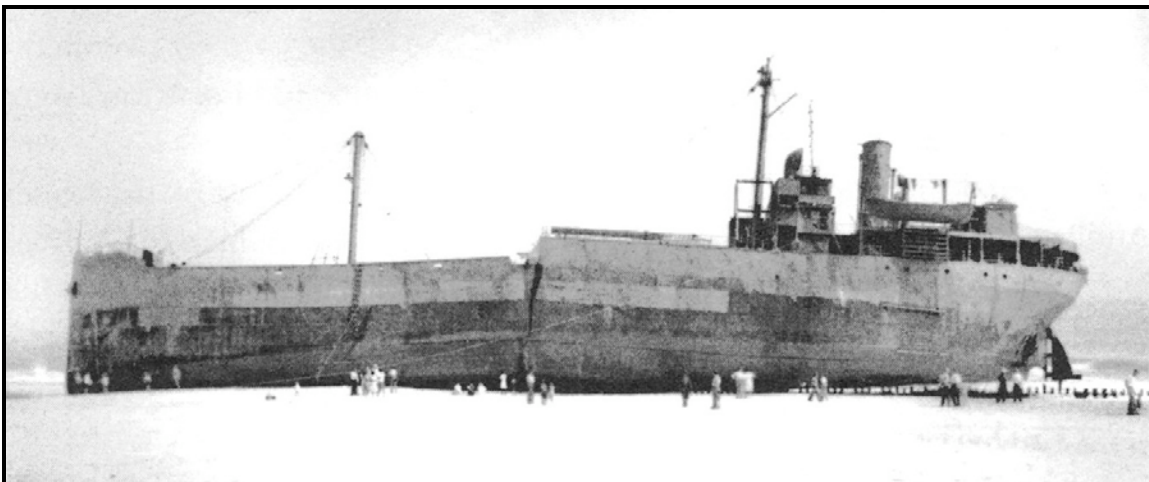


Figure 5. The *Thomas Tracy* aground at Rehoboth Beach. The frames of the *Merrimack* can be seen below the stern of the *Thomas Tracy*.



Figure 6. The *Black Spoonbill* aground at Rehoboth Beach.

Pilots Plying the River and Bay from Said Port" (McHugh 1983:24). The Wardens took on the responsibility of licensing pilots, placing buoys, alleviating the problem of winter icing, erecting lighthouses, dredging, and constructing wharves and piers. However, navigational aids were not uniformly regulated until the second half of the nineteenth century. A set of 1796 sailing directions mentions that buoys were placed on Brown, Brandywine, and Cross-ledge shoals. By 1827, additional buoys were positioned on Joe Flogger, Fourteen Bank, and Upper Middle shoals.

Shoals were the principal navigational hazard in the Delaware Bay. They accumulated throughout the bay and were constantly shifting. The average water depth in the early nineteenth century was between 15 and 25 feet in the main channel. This provided adequate draft for most of the vessels then plying the bay. But by the 1880s, a normal sea-going vessel had a typical draft of 20 to 24 feet and could easily ground in the channel without the benefit of a full tide.

Finally in 1885, legislation was enacted to authorize the permanent improvement of the Delaware Bay/River. From that time the Army Corps of Engineers supervised all improvements on the waterway, including dredging, and the construction and maintenance of anchorages, dikes, and harbors. Furthermore, the River and Harbor Act of 1896 authorized a 30-foot channel from the mouth of the bay to Philadelphia. The current main shipping-channel dredging project of the army corps was adopted in 1910 and modified in 1930, 1933, 1935, 1938, 1945, 1954, and 1958. The depth was originally 30 feet, but it was revised twice during the twentieth century, once to 35 feet and finally to the present 40-foot channel. The 40-foot channel was completed in 1942 (Snyder and Guss 1974:69).

Implications of Prehistoric and Historic Research

Examination of the prehistoric and historic records provides some insight into the potential nature of submerged cultural resources in the project area. Investigations of prehistoric archaeological sites in the project area have generated sufficient data to confirm the nature of settlement patterns along coastal Delaware from the Archaic through the Woodland II period. Although some of the evidence discussed in conjunction with environmental considerations suggests that there is a possibility that portions of the prehistoric archaeological record may have survived the inundation process, the high energy coastal environment and relatively fragile nature of Delaware Coastal Zone sites would appear to offer limited potential for research.

Both the Paleo-Indian and Archaic lifestyles were highly mobile, generating minimal archaeological evidence. While lithic material associated with Paleo and Archaic populations would without question survive the inundation process the more delicate archaeological evidence would probably be destroyed. While the lithic evidence could contribute to an understanding of the distribution of populations in Delaware prehistory, site-specific data would no doubt be limited. The more sedentary lifestyles and greater population densities associated with the Woodland I and Woodland II inhabitants of the Delaware Coastal Zone produced a much more extensive and complex archaeological record. Lithic, and

to a lesser degree ceramic, artifacts would no doubt survive the inundation process and preserve indications of the distribution of Woodland I and Woodland II populations. In addition, some highly stratified sites encapsulated by sediment or shell middens prior to the inundation process could also contain a recoverable archaeological record. Unfortunately, sub-bottom evidence of these sites would be difficult to identify.

Historical evidence suggests that the submerged archaeological record in the survey area could also contain both material associated with terrestrial settlement and maritime activities. While habitation along the shore of the Delaware adjacent to the project area has been light, the nature of early settlement suggests that archaeological evidence generated by terrestrial activity could contain both artifacts and features. As previously discussed, examination of historic period habitation sites inundated in association with similar environments has confirmed the preservation of portions of the archaeological record. However, due to limited early population, the majority of material associated with terrestrial habitation may be associated with modern use patterns.

Exploration, colonization, and development of coastal Delaware have generated extensive vessel traffic in the vicinity of the survey area. As the shipwreck list confirms (Appendix A), ship losses can be documented as early as the last quarter of the eighteenth century. Given the amount of documented activity prior to that date, it is only reasonable to assume that the earliest ship losses date from the seventeenth century. Because of the nature of historical activity on the Delaware, ship losses include a rich variety of vessel types. Many of these should prove to be small vessels associated with exploration, colonization, fishing, hunting, and coastal trade and transportation. As historical records rarely identify small vessel losses, their extent is difficult to determine by historical research. The fact that these small vessels rarely appear in the historical record enhances their archaeological value. Unfortunately, they are also the most difficult to locate as their remains produce a minimal magnetic and acoustic remote-sensing signature.

Because the Delaware River developed into a major artery for transportation and trade in the Colonial Period, shipwrecks at the mouth of the Bay include a representative sampling of the major eighteenth-, nineteenth-, and occasionally twentieth-century ship types. While deep-water channels would have ordinarily carried large vessels away from the vicinity of the project area, adverse weather and human error could have contributed both wrecks and shipwreck associated remains to the project environment.

The history of the area off Rehoboth Beach, relating specifically to the area surveyed, follows several themes identified in the Delaware State Plan: Agriculture, Forestry, Fishing/Oystering, Retailing/Wholesaling, and Transportation and Communication. These occur in all the historic context periods established in the State Plan.

Remote-Sensing Survey Methodology

In order to reliably identify submerged cultural resources, TAR archaeologists conducted a systematic remote-sensing survey of the proposed borrow sites. Underwater survey activities were conducted from the 25-foot survey vessel *Atlantic Surveyor* (Figure 8). In order to fulfill the requirements for survey activities in Delaware, magnetic and acoustic remote-sensing equipment were employed. This combination of remote-sensing represents the state of the art in submerged cultural resource location technology and it offers the most reliable and cost effective method to locate and identify potentially significant targets. Data collection was controlled using a differential global positioning system (DGPS). DGPS produces the highly accurate coordinates necessary to support a sophisticated navigation program and assures reliable target location.



Figure 8. The 25-foot *Atlantic Surveyor*.

Magnetometers

Magnetometers measure the earth's magnetic field in gammas and identify anomalies that represent both geological features and cultural material associated with human activity. Because of the association of ferrous material and material having thermoremanent magnetism with shipwrecks and other submerged cultural resources, magnetometers have been adopted by archaeologists as one of the principal tools employed in submerged cultural resource surveys.

State-of-the-art magnetometers use cesium vapor or hydrogen to measure the magnetic field and virtually all have processing components in the sensor for high sensitivity and very low noise (Geometrics 2003; Marine Magnetism 2003). All utilize digital technology, even the low-end proton precession magnetometers that remain on the market (Geometrics 2003). Both the cesium vapor and Overhauser sensor instruments are advertised to have much greater sensitivity than proton precession instruments (Marine Magnetism 2003). Multiple sensor instruments have been developed to operate as gradiometers, providing amplified data that include target direction, size, and distance (Geometrics 2003; Marine Magnetism 2003; Michel et al. 2004).

Although all of the new generation magnetometers can be connected via a computer to a printer, data are almost universally computer displayed in real time. Data display can be achieved by a computer dedicated to the magnetometer, or the magnetometer can be connected directly to the navigation computer for both real time display and data storage. Targets can be filed and represented on the navigation display by a keystroke. All magnetometers can be fitted with depth and/or altitude sensors to facilitate maintaining survey altitude requirements (Geometrics 2003; Marine Magnetism 2003; Michel et al. 2004).

A GEOMETRICS G-881 marine cesium-vapor magnetometer, capable of plus or minus 0.001 gamma resolution, was employed to collect magnetic data in the survey areas (Figure 9). To produce the most comprehensive magnetic record, data was collected at 10 samples per second. The magnetometer sensor was towed approximately 10 feet below the water surface at a speed of approximately four knots. Magnetic data were recorded as a data file associated with the computer navigation system. Data from the survey were contour plotted using QUANTUM GIS computer software to facilitate anomaly location and definition of target signature characteristics. All magnetic data were correlated with the acoustic remote-sensing records.

Side Scan Sonars

Side scan sonars utilize sound to generate images of bottom surface geological features and cultural material such as shipwrecks. Transducers located on the sides of a towfish generate sound that travels through the water column at a known speed. The towfish transducers also record sound returning from the bottom surface and other exposed material. By processing the strength and variable time of returning sound, a highly detailed image of the bottom and any other exposed material can be generated. Today high-resolution sonar can produce images that are almost photographic in quality and detail (Mazel 1985).

While most side scan sonar systems are equipped to interface with recorders that generate paper records, they are designed to present and store data electronically. Virtually all sonar units available today operate on computer-based systems. Computer-based systems have advanced high-speed signal processing and most sensors are equipped with much improved transducers that provide better control over beam transmission and reception. In addition,



Figure 9. Launching the GEOMETRICS G-881 cesium vapor magnetometer.

computer-based systems are programmed to connect record processing with real world geographical coordinates, permitting the computer to correct for speed and eliminate slant range error in real time by program functions (Michel et. al. 2004). Computer-generated resolution is higher and tow speeds can be significantly increased. Most new systems are designed to operate at dual frequencies such as 100kHz/500 kHz or 500kHz/900kHz (Benthos 2003, EdgeTech 2003, Klein Associates 2003). All of those improvements contribute to higher resolution images. The higher the resolution of the sonar data, the more diagnostic the image.

A 445/900 kHz KLEIN SYSTEM 3900 digital sidescan sonar (interfaced with SONARPRO SONAR PROCESSING SYSTEM) was employed to collect acoustic data in the survey areas (Figure 10). The side scan sonar transducer was deployed and maintained approximately 10 feet below the water surface. Acoustic data were collected using a range scale of 164 feet (50 m) to provide a minimum of 500% coverage and high target signature definition. Acoustic data were recorded as a digital file with SONARPRO and tied to the magnetic and positioning data by the computer navigation system.

Limitations of Magnetic and Acoustic Remote-Sensing

Magnetic Remote-Sensing

The magnetometer represents one of the most valuable tools available for locating submerged cultural material. One distinct advantage associated with magnetic detection is that material can be buried and still generate an identifiable signature. However, magnetic remote-sensing has limitations that should be acknowledged. Since disturbances in the earth's magnetic field are relative to both the mass and physical characteristics of ferrous and thermoremnant material, a number of factors influence detectable signatures. One of the most critical is survey lane spacing. Acceptable lane spacing must be determined based on the anticipated nature of submerged cultural resources in the survey area. For example the signature of a large iron ship would be detectable over a considerably longer distance than a small wooden vessel. Thus the lane spacing adopted to reliably locate a large ship could be considerably greater than that employed for a small wooden vessel.



Figure 10. Launching the KLEIN SYSTEM 3900 digital side scan sonar.

The proximity of the sensor to material generating the anomaly is another important factor. As the magnetometer is not range specific, the size and composition of material generating an anomaly in the earth's magnetic field combine to establish the distance at which magnetic material creates the

detectable disturbance. For example a small anchor will be detectable for a much more limited distance than the iron hull of a vessel. Therefore, sensor elevation in the water column and line spacing have a great deal to do with the size and characteristics of an anomaly that will be identifiable. Vessel speed and the cyclical rate of data collection will also have a bearing on the detectable characteristics of an anomaly. Higher speed and/or a slower cyclical rate can turn the subtle characteristics of a multi-component signature into one of the other three signature types; negative monopolar, positive monopolar or dipolar.

Currently, 100-foot (30 m) lane spacing is considered acceptable for most offshore areas. In inshore areas or offshore areas where historical sources confirm that vessel traffic and losses have been high, 50-foot (15 m) lane spacing is considered acceptable. However, neither of those line spacings will ensure 100% likelihood of identification. Vessel signatures vary significantly. Even at a 50-foot (15 m) lane spacing, identifying the remains of small vessels could be a factor of the chance position of a single survey line in relationship to the wreck. Several examples of detectable limitations can be found in a report on "State-of-the-Art Remote-sensing Equipment, Software and Survey Methodology in Submerged Cultural Resource Identification, Protection and Management" incorporated in a Minerals Management Service publication titled: *Archaeological Damage from Offshore Dredging: Recommendations for Pre-Operational Surveys and Mitigation During Dredging to Avoid Adverse Impacts* (OCS Report MMS2004-005) (Michel et al. 2004).

In addition to lane spacing, background noise also plays a role in isolating small signatures. When small vessel remains and other cultural resources create limited disturbances in the earth's magnetic field, background noise can obscure the signature. Fortunately modern magnetometer systems are highly stable and background noise is limited unless there are significant geological features, solar activity and vessel-generated noise. In addition to background noise, modern debris, cables, pipelines and structures such as offshore rigs, bridges, docks and bulkheads can mask subtle signatures. An excellent example can be found in the remains of two vessels located adjacent to the Jordan Point Bridge on the Southern Branch of the Elizabeth River in Chesapeake, Virginia. Neither vessel, both large wooden ships over 150 feet in length (Figure 11), was magnetically detectable (Figure 12) due to the massive magnetic disturbance created by adjacent bridge and pier structures, cables and bulkheads (Watts 2009).

Unfortunately, shipwreck sites have been demonstrated to produce each signature type under certain circumstances. Some shipwreck signatures are more apparent than others. Large vessels, whether iron or wood produce signatures that can be reliably identified. Smaller vessels, or disarticulated vessel remains, are more difficult to identify. Their signatures are frequently difficult, if not impossible, to distinguish from single objects and/or modern debris. In fact, some small vessels produce little or no magnetic signature. Unless ordnance, ground tackle or cargo associated with the hull produces a detectable signature,

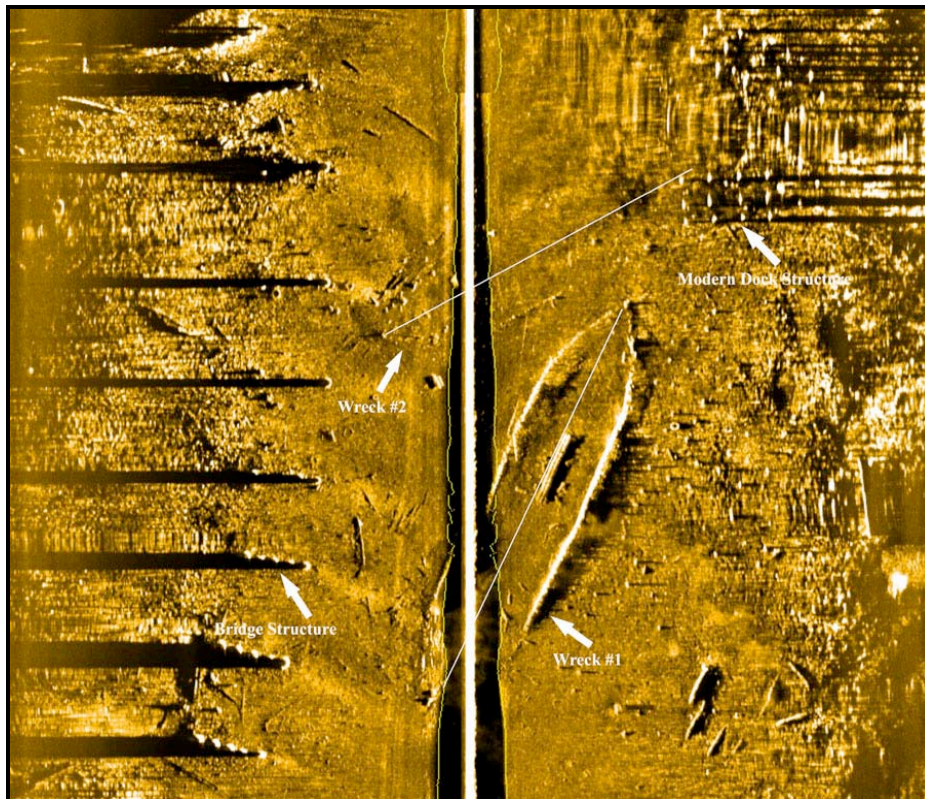


Figure 11. Sonar image of the Jordan Bridge shipwrecks.

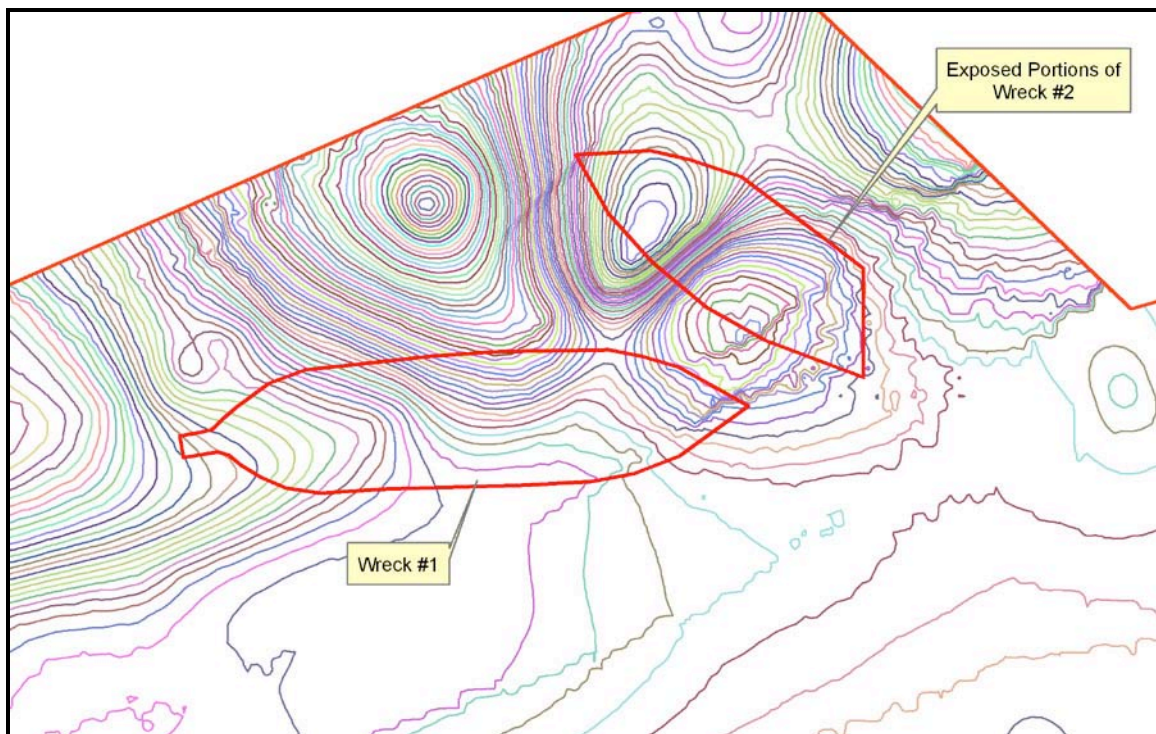


Figure 12. Magnetic contour map illustrating the masking of vessel signatures by bridge and pier structures, cables and bulkheads.

some sites are impossible to identify magnetically. For example, the remains of the Mepkin Abby vessel in the Cooper River near Charleston, South Carolina produced no magnetic signature. Instead the site was identified solely by sonar (Figure 13). It is also difficult to magnetically distinguish some small wrecks from modern debris. As a consequence, magnetic targets must be subjectively assessed according to intensity, duration and signature characteristics. The final decision concerning potential significance must be made on the basis of anomaly attributes, historical patterns of navigation in the project area and a responsible balance between historical and economic priorities.

Sonar Remote-Sensing

Used in conjunction with magnetometers, side scan sonars can generate valuable diagnostic insight into the nature of material generating magnetic anomalies. In addition, sonar can identify the exposed remains of vessels and other cultural material that does not create a ferrous or thermoremanent magnetic signature. Because sonar generates highly valuable diagnostic data, side scan sonars have also been adopted by archaeologists and submerged cultural resource managers to locate and identify shipwrecks and other submerged cultural resources.

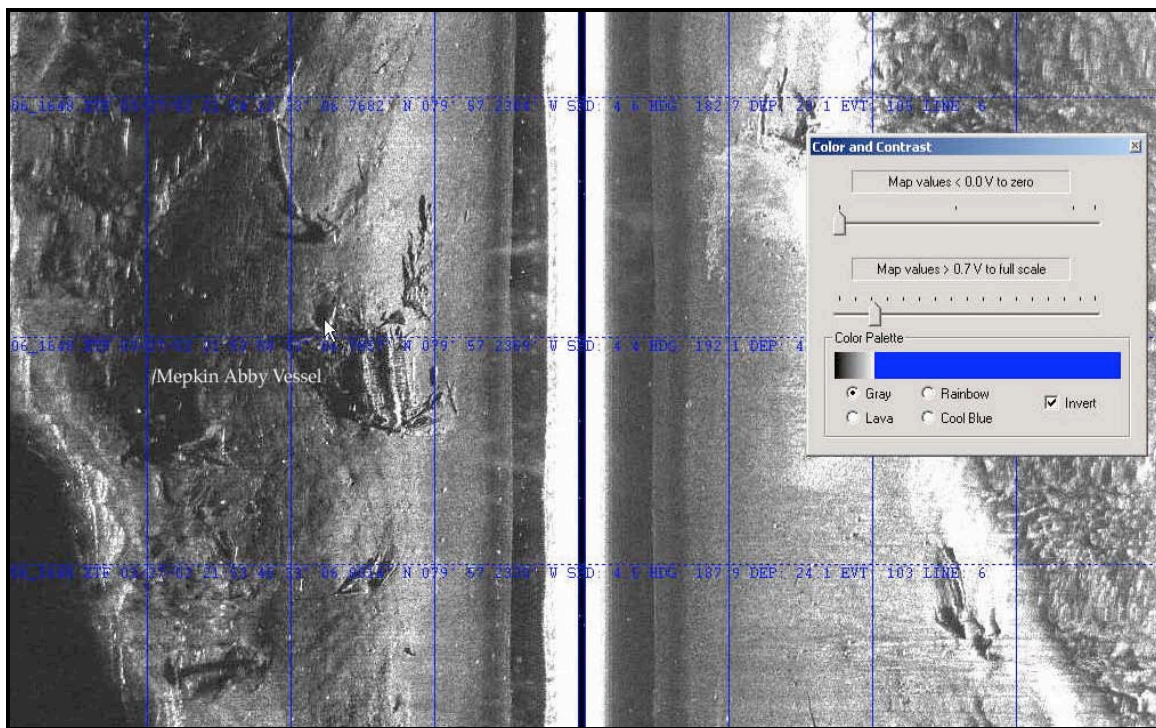


Figure 13. High resolution sonar image of the Mepkin Abby wreck in the Cooper River near Charleston, South Carolina (image courtesy of Ralph Wilbanks).

Unfortunately, shipwreck sites have been demonstrated to produce a variety of signature characteristics under different circumstances. Like magnetic signatures, some acoustic shipwreck signatures are more apparent than others.

Large vessels, whether iron or wood, produce signatures that can be reliably identified. Smaller vessels, or disarticulated vessel remains are inevitably more difficult. Their signatures are frequently difficult, if not impossible, to distinguish from concentrations of snags and/or modern debris. In fact, some small vessels produce little or no acoustic signature. As a consequence, acoustic targets must be subjectively assessed according to intensity of return over background, elevation above bottom and geometric image characteristics. The final decision concerning potential significance of less readily identifiable targets must be made on the basis of anomaly attributes, historical patterns of navigation in the project area and a responsible balance between historical and economic priorities.

Like magnetic remote-sensing, side scan sonar also has limitations to be considered. For different reasons, sensor to target distance is also critical. Again, the size of anticipated vessel remains or other submerged cultural material is a significant issue in survey line spacing. For targets such as the remains of large vessels, a broad survey pattern may generate acceptable results. For smaller and less distinctive targets such as the remains of small, disarticulated or partially exposed vessels, much closer line spacing may be required to produce acceptable results.

Another consideration associated with line spacing is operational frequency and range selection. The lower the frequency the more extended the range but the lower the resolution. The higher the frequency the better the resolution but the more limited the range. Where larger targets are anticipated the lower frequency and higher range will produce reliable results. Where more subtle targets are anticipated, and that must generally be the case with submerged cultural resource surveys, a higher frequency and closer line spacing is essential. The 100-foot (30 m) and 50-foot (15 m) line spacing generally adopted for magnetometer surveys produces excellent high frequency sonar images on a 50 meter (164-foot) range scale. That range scale and line spacing also provides excellent overlap in coverage and multiple images of each target.

High quality diagnostic sonar image production can also be impacted by both environmental and survey conditions. Under certain conditions the water surface can produce a deceptive return that could be construed to represent real targets. Rough water conditions, particularly in shallower water where the transducer cannot be lowered sufficiently, can distort images. Biological and marine animal activity can also impact record quality as floating vegetation, shrimp, fish, dolphin and other marine organisms can create deceptive imagery. On more than one occasion schools of fish have been identified as ballast piles in submerged cultural resource reports (Figure 14). Vessel course and speed can also have an impact on sonar record quality. With the exception of side scan sonars designed for high speed operations, vessel speed over ground has a direct bearing on target resolution as the number of pings on a target relates directly to resolution. Finally, noise generated by vessel power sources and other acoustic equipment can also degrade record quality.

Several examples of detectable limitations can be found in a report on “State-of-the-Art Remote-sensing Equipment, Software and Survey Methodology in Submerged Cultural Resource Identification, Protection and Management” incorporated in a Minerals Management Service publication titled *Archaeological Damage from Offshore Dredging: Recommendations for Pre-Operational Surveys and Mitigation During Dredging to Avoid Adverse Impacts* (OCS Report MMS2004-005) (Michel et al. 2004).

Positioning and Data Collection

A TRIMBLE AgGPS was used to control navigation and data collection in the survey areas. That system has an accuracy of plus or minus three feet, and can be used to generate highly accurate coordinates for the computer navigation system on the survey vessel. The DGPS was employed in conjunction with an onboard laptop loaded with HYPACK navigation and data collection software (Figure 15). Positioning data generated by the navigation system were tied to

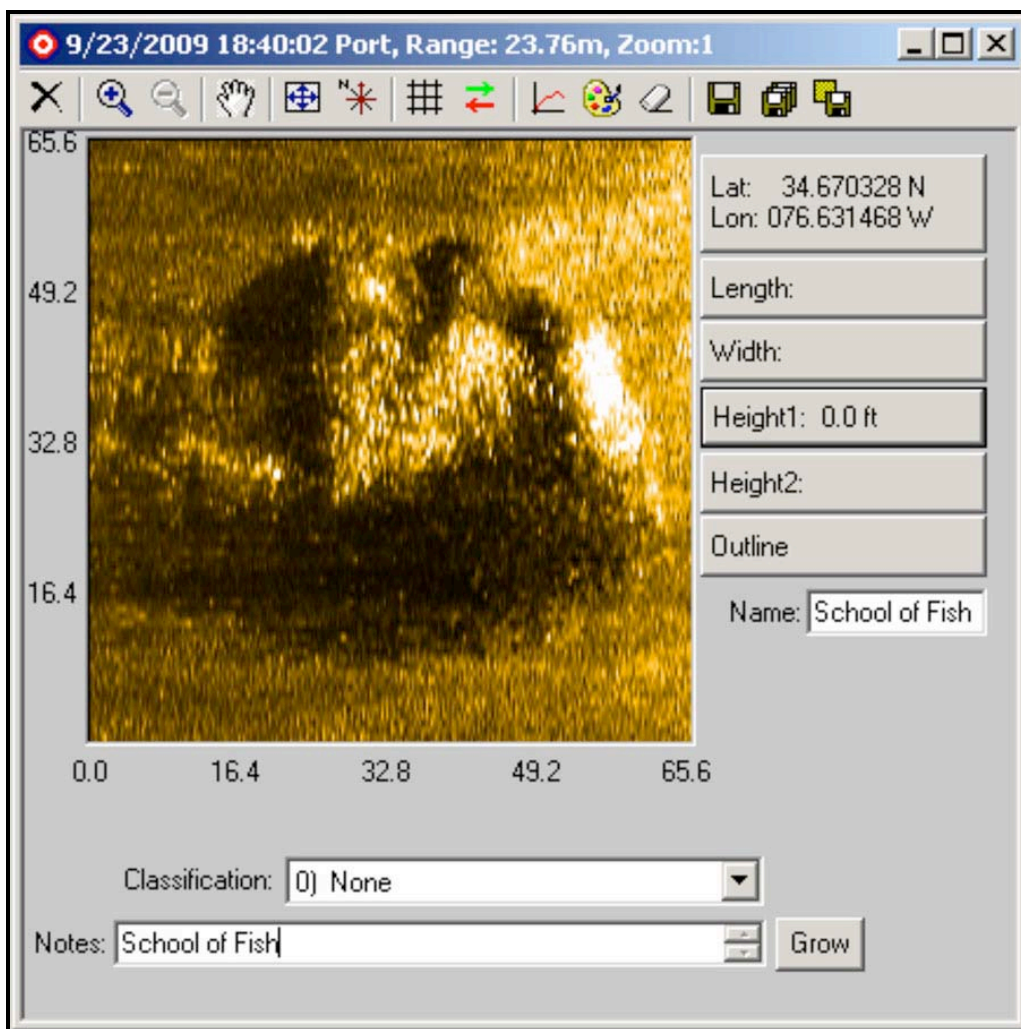


Figure 14. A school of fish generating the appearance of a ballast pile.



Figure 15. Computer navigation system located at the research vessel helm.

magnetometer records by regular annotations to facilitate target location and anomaly analysis. All data is related to the Delaware State Plane Coordinate System, NAD 83, U.S. Survey Foot.

Signature Analysis and Target Assessment

No absolute criteria for identification of potentially significant magnetic and/or acoustic target signatures exist. However, available literature confirms that reliable analysis must be made on the basis of certain characteristics. The most reliable signature analysis can be made by comparative analysis of both magnetic and acoustic data. Data analysis should also be carried out with consideration of the limitations of each instrument and the environment in which survey operations are conducted.

Magnetometer Data Collection and Analysis

Data from the magnetometer is collected using HYPACK and stored as *.RAW files by line, time, and day. RAW data files are opened and reviewed in HYPACK Single Beam Editor and layback parameters are set. The location, strength, duration, and type of anomaly are then transcribed to a spreadsheet along with comments. Contour maps of the magnetic data are produced with QUANTUM GIS, an open source geographic information system, and saved as shapefiles. Those shapefiles are imported to an ARCMAP project to create the report maps. The contour maps provide a graphic illustration of anomaly locations, spatial extent, and association with other anomalies.

Magnetic signatures are evaluated on the basis of three basic factors. The first factor is intensity and the second is duration. The third consideration is the nature of the signature; e.g., positive monopolar, negative monopolar, dipolar or multi-component. In conjunction with signature intensity in gammas and duration in feet, those four signature configurations are used to characterize virtually all magnetic anomalies.

Side Scan Sonar Data Collection and Analysis

Data correlated with DGPS positioning coordinates were recorded as *.XTF files and stored by project and line designation. Data were recorded at both 445 and 900 kHz frequencies. The sonar towfish was towed approximately 10 feet below the water surface and operated at a range scale of 50 meters per channel. On 50-foot (15 m) line spacing that range scale generated over 500 percent overlapping data.

Post-processing of side scan sonar is accomplished using SonarWiz.MAP, a product that enables the user to view the side scan data in digitizer waterfall format, record targets and enter target parameters including length, width, height, material and other characterizations into a database of contacts. In addition, SonarWiz.MAP mosaics the side scan data by associating each pixel (equivalent to about .3 feet) of the side scan image with its geographic location determined from the distance from the DGPS position. SonarWiz.MAP is the industry standard for creating sonar mosaics, and the results are exported as geo-referenced TIFFs and imported into the GIS project. SonarWiz.MAP also generates target reports in PDF, Word, or Excel format. TAR utilizes the Word format for reports.

Acoustic signatures must be assessed on the basis of several basic characteristics. Perhaps the most important factor in acoustic analysis is the configuration of the signature. As the acoustic record represents a reflection of specific target features, wreck signatures are often a highly detailed and accurate image of architectural and construction features (Figure 16). On sites with less structural integrity, signatures often reflect more of a geometric pattern that can be identified as structural material (Figure 17). Where hull remains are disarticulated the pattern can be little more than a texture on the bottom surface representing structure, ballast or shell hash associated with submerged deposits (Figure 18).

Data Analysis

To ensure reliable target identification and assessment, analysis of the magnetic and acoustic data was carried out as it was generated. Using QUANTUM GIS contouring software, magnetic data generated during the survey were contour plotted for analysis and accurate location of magnetic anomalies. The magnetic data was examined for anomalies, which were then isolated and analyzed in accordance with intensity, duration, areal extent and signature characteristics. Sonar records were analyzed to identify targets on the basis of configuration,

areal extent, target intensity and contrast with background, elevation and shadow image, and were also reviewed for possible association with identified magnetic anomalies.

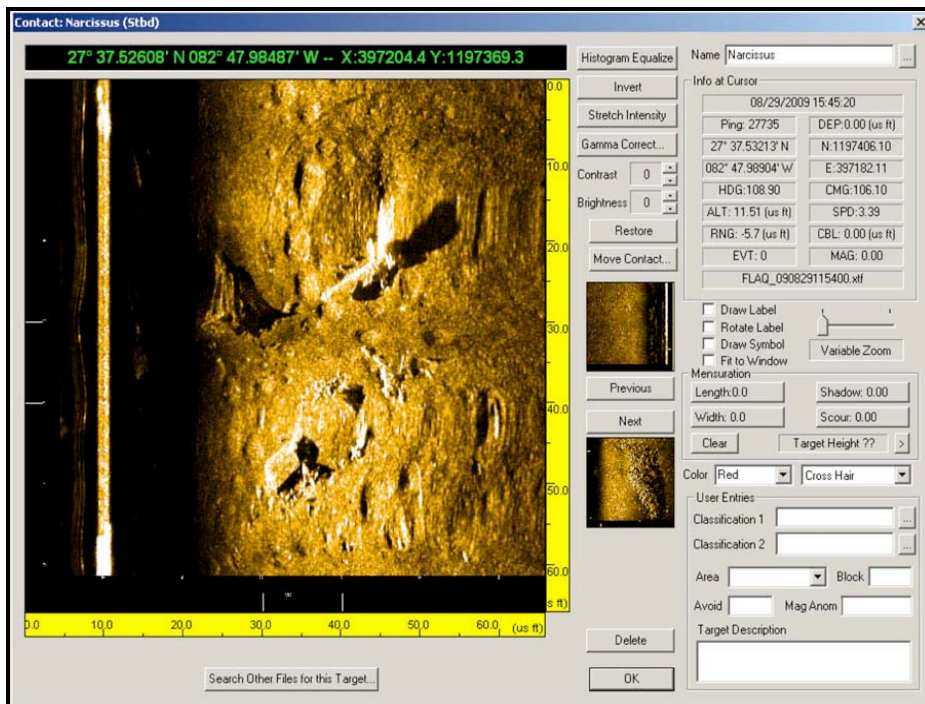


Figure 16. A sonar image of the USS *Narcissus* showing the exposed engine, propeller, boiler, and hull debris.

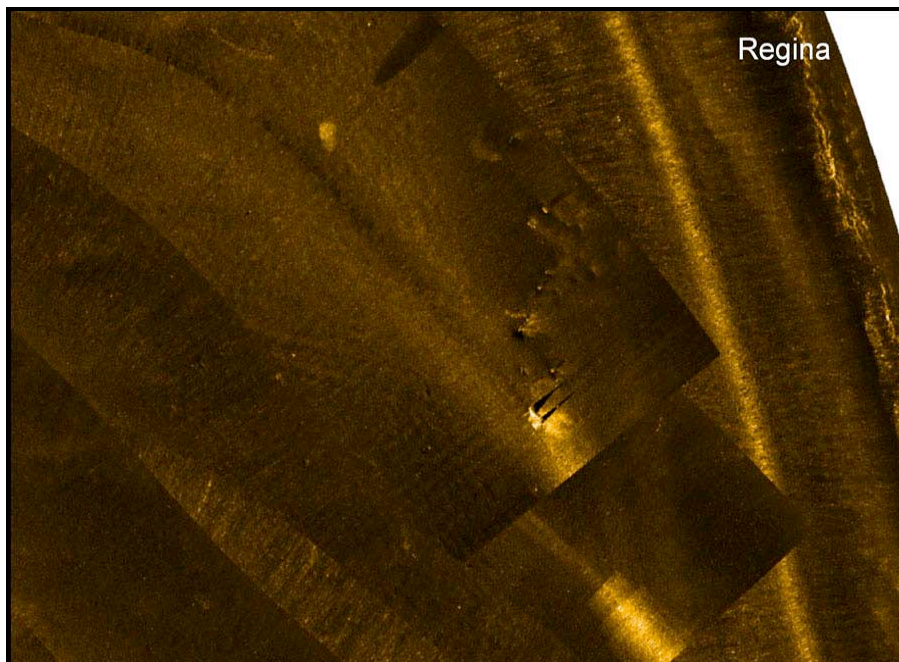


Figure 17. A sonar mosaic of the barge *Regina*.

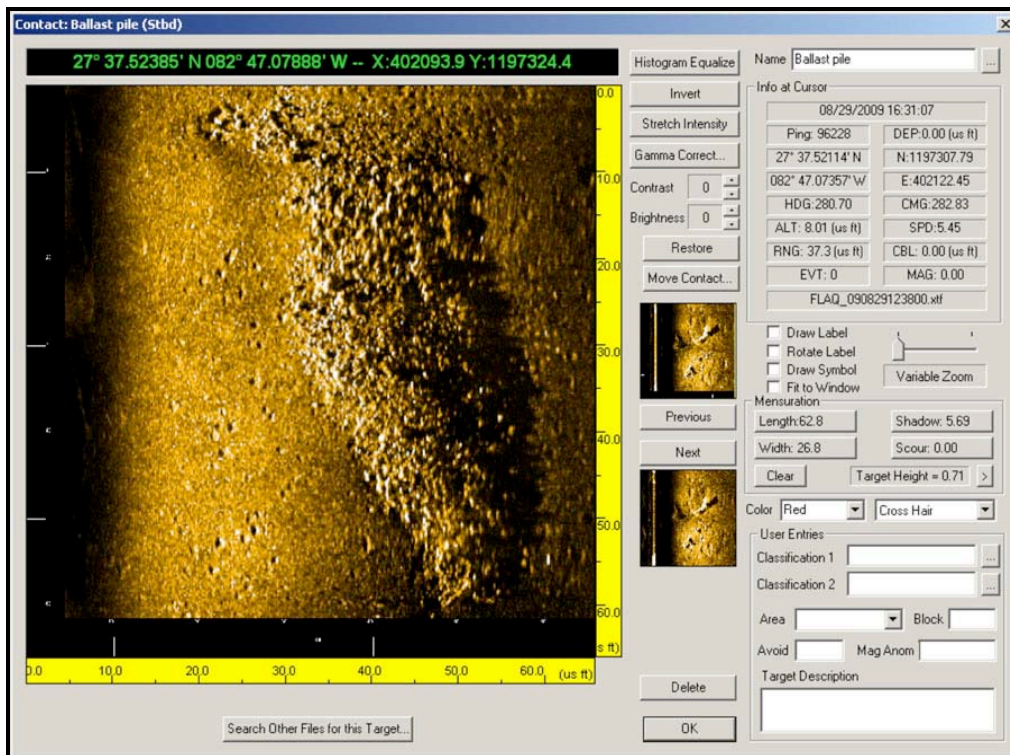


Figure 18. A sonar image of the ballast pile east of the USS *Narcissus*.

Data generated by the remote-sensing equipment were developed to support an assessment of each magnetic and acoustic signature. Analysis of each target signature included consideration of magnetic and sonar signature characteristics previously demonstrated to be reliable indicators of historically significant submerged cultural resources. Assessment of each target includes avoidance options and possible adjustments to avoid potential cultural resources. Where avoidance is not possible the assessment includes recommendations for additional investigation to determine the exact nature of the cultural material generating the signature and its potential NRHP significance. Historical evidence was developed into a background context and an inventory of shipwreck sites that identified possible correlations with magnetic targets (Appendix A). Magnetic contour maps of the survey areas were produced to aid in the analysis of each target.

Previous Investigations

In 1995, the U.S Army Corps of Engineers, Philadelphia District, studied shoreline erosion along the Atlantic Coast of Delaware (Cox 1995). As part of this study, Dolan Research of Philadelphia, Pennsylvania was contracted to conduct a remote-sensing survey of two potential borrow areas that were identified for further study; one off Dewey Beach, the other off Bethany Beach. Analysis of the remote-sensing data identified two magnetic and one acoustic target in the Dewey Beach area, and one magnetic target in the Bethany Beach area. The three magnetic targets were identified as having a high potential for potentially significant cultural resources and were recommended for avoidance.

In 2001, the U.S Army Corps of Engineers, Philadelphia District, contracted Dolan Research of Philadelphia, Pennsylvania to conduct a remote-sensing survey of three potential borrow areas that were identified for further study; one at the entrance to Indian River Inlet (Inlet Area), one adjacent to and south of the inlet (Borrow Area G), and one off Rehoboth Beach (Borrow Area B) (Cox 2001). Analysis of the remote-sensing data identified eight remote-sensing targets in the survey areas. Only one target in Borrow Area G was identified as having a high potential for potentially significant cultural resources and was recommended for avoidance.

Summary of Findings

Analysis of the remote-sensing data identified a total of 23 magnetic anomalies and 8 sonar targets (Figure 19 and Figure 20; Appendix B and Appendix C). One magnetic anomaly, M-7, is located outside the area and six magnetic anomalies, M-5, M-6, M-8, M-11, M-12, and M-13, produced signature characteristics of small single objects such as fish and crab traps, pipes, small diameter rods, cable, wire rope, chain or small boat anchors and are not recommended for avoidance. One sonar target, SS-1, appeared to be produced by an approximately 40-foot section of pipe. Three magnetic anomalies, M-4, M-9, and M-10, and five sonar targets, SS-2, SS-3, SS-4, SS-5, and SS-6, are associated with two buoys moored at the approximate ends of the proposed outfall pipes (Figure 21). Ten magnetic anomalies, M-14, M-15, M-16, M-17, M-18, M-19, M-20, M-21, M-22, and M-23 in the northwest corner of the survey area produced signature characteristics suggestive of small diameter, degraded pipe or chain. As these 20 magnetic anomalies and 6 sonar targets are suggestive of isolated modern debris, no additional investigation is recommended.

A significant increase in the magnetic background was found along the southwestern perimeter of the survey area. That distortion in the earth's magnetic field masked any signature generated by the section of pipe identified in the sonar records as SS-1. The source of that distortion lies outside the survey area and appeared to be a multi-story building on the adjacent beach (Figure 22).

The signature characteristics of three magnetic anomalies, M-1, M-2, and M-3 and two sonar targets, SS-7 and SS-8, should be considered indicative of potentially significant cultural material. While not in the immediate vicinity of the proposed outfall pipes, the objects producing these signatures should be protected by a 200-foot radius buffer. Should avoidance prove impossible, additional investigation, designed to evaluate the material in terms of NRHP eligibility, should be conducted. In order to be NRHP eligible, a site must meet one or more of four criteria:

1. Association with events that have made a significant contribution to the broad patterns of our history;
2. Association with the lives of persons significant in our past;

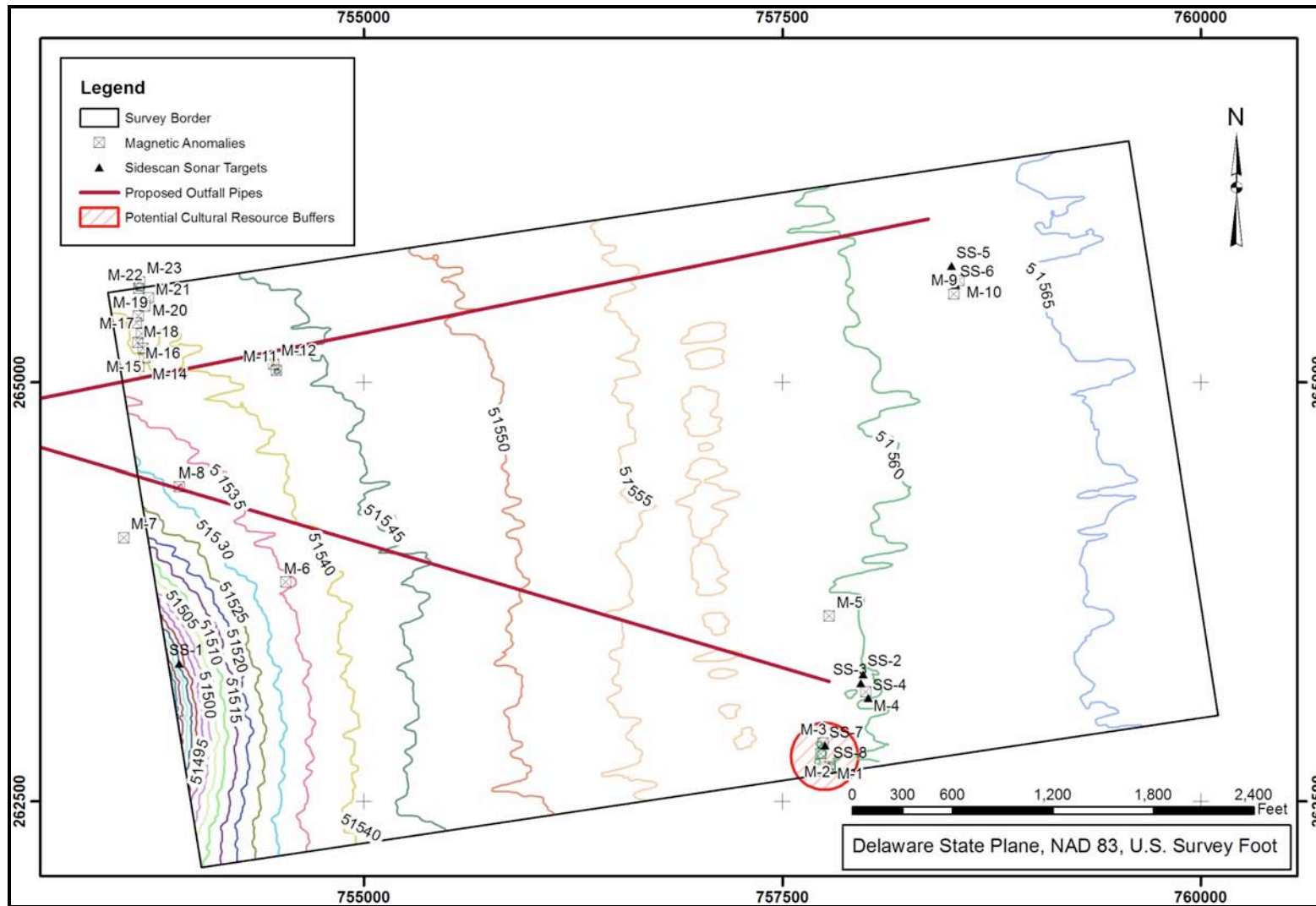


Figure 19. Magnetic contour map.

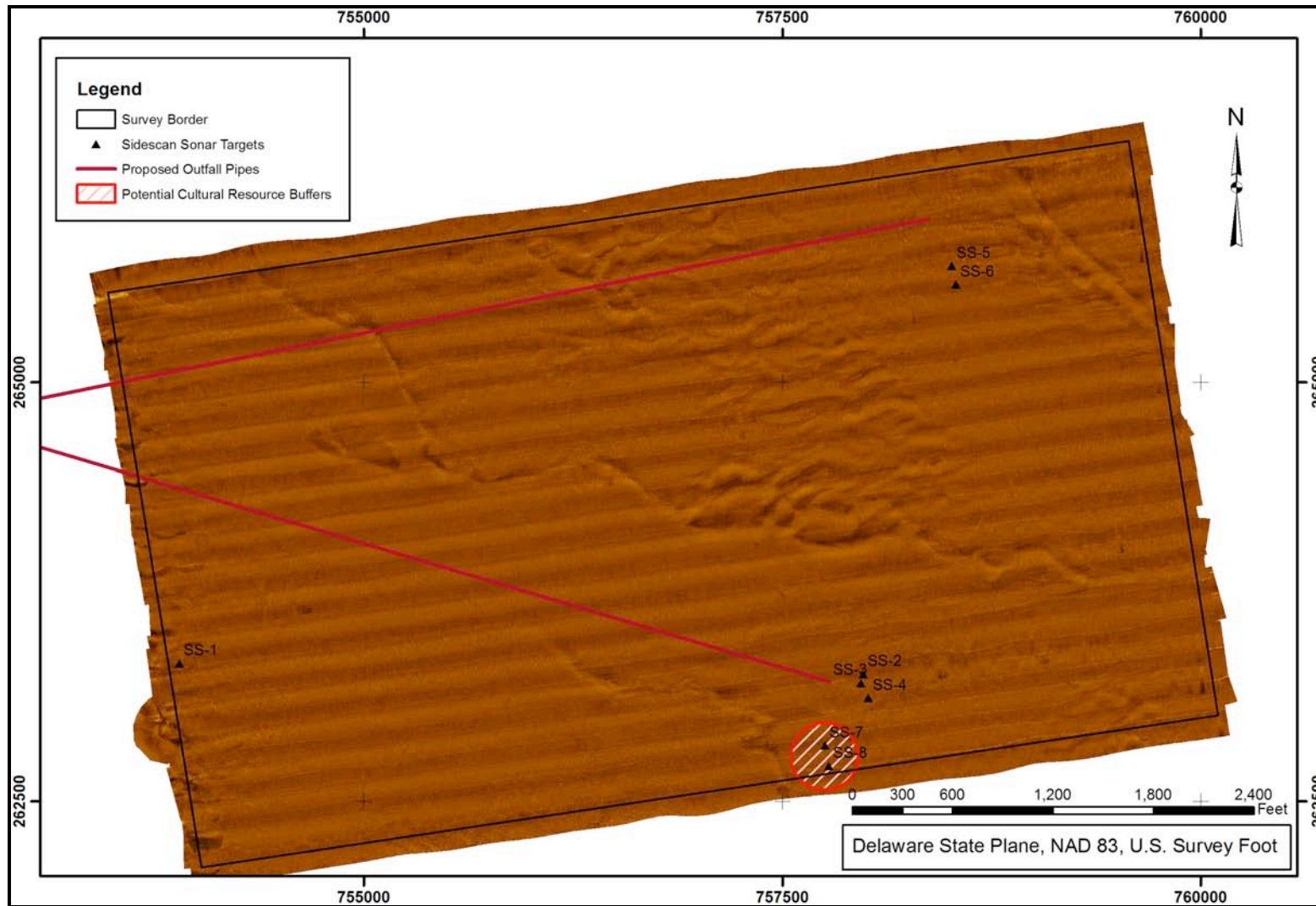


Figure 20. Sidescan sonar coverage map.



Figure 21. One of two buoys located in the survey area.

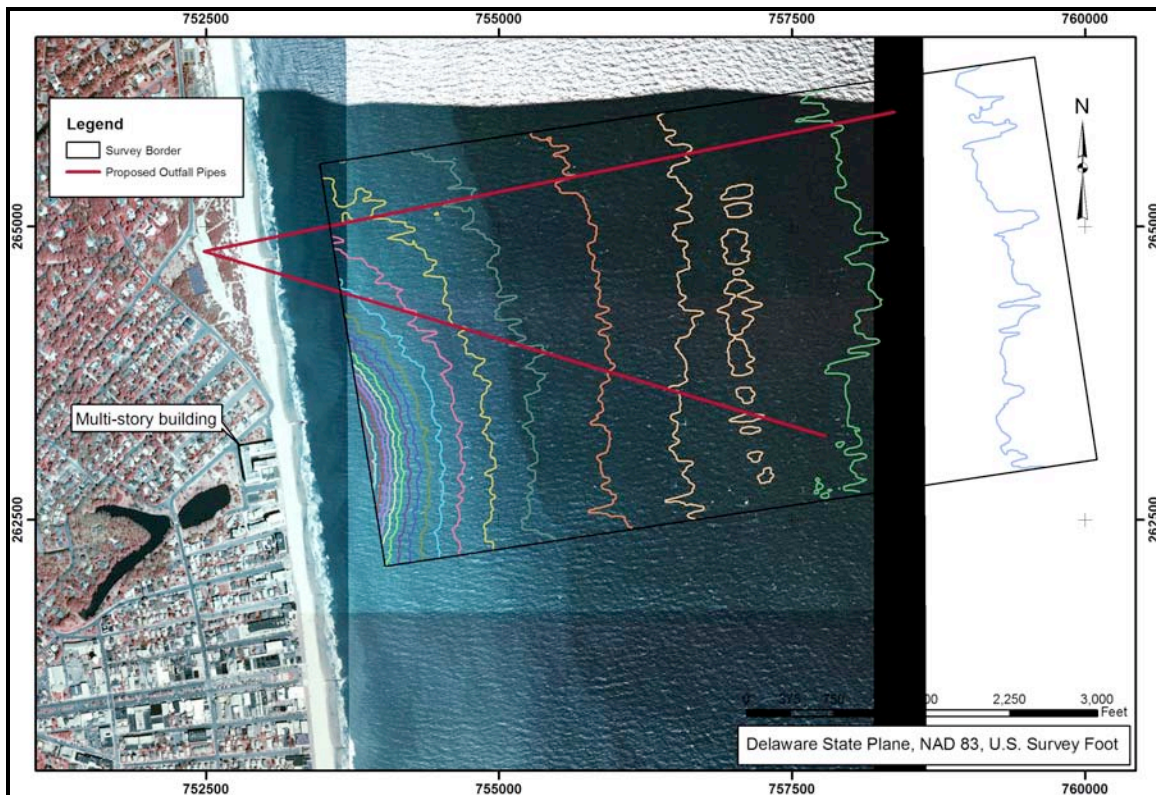


Figure 22. Beachfront building likely responsible for the magnetic distortion outside the southwestern perimeter of the survey area.

3. The site embodies distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction;
4. Yields, or may be likely to yield, information important in prehistory or history.

Conclusions

Historical background research and the documented loss of vessels in the vicinity of the Delaware Bay confirm that ship traffic in the vicinity of the study area has increased continuously since the earliest period of colonial development. The historical narrative and shipwreck appendix confirm that shipwrecks in the vicinity of Cape Henlopen preserve a representative sample of that ship traffic through time. The majority of area wrecks are associated with deep-water channels and navigation at the entrance to Delaware Bay. Ship traffic associated with that busy waterway likely resulted in the deposition of shipwreck remains in the vicinity of the Rehoboth Beach survey area. Stranding of the *Merrimac*, *Severn*, *Thomas Tracy*, and *Black Spoonbill* confirms the presence of vessels in the immediate vicinity of the study area. The variety of other historically documented wrecks in the project vicinity establishes the high potential for additional shipwreck remains.

Analysis of the survey remote-sensing data revealed a total of 23 magnetic anomalies and 8 sonar targets. Twenty magnetic anomalies and 6 sonar targets are suggestive of isolated modern debris and no additional investigation is recommended. The signature characteristics of three magnetic anomalies and two sonar targets should be considered indicative of potentially significant cultural material. While not in the immediate vicinity of the proposed outfall pipes, the objects producing these signatures should be protected by a 200-foot radius buffer. Should avoidance prove impossible, additional investigation, designed to evaluate the material in terms of NRHP eligibility, should be conducted.

Survey forms, survey data, maps, drawings, photographs, and forms will be curated at the offices of Tidewater Atlantic Research in Washington, North Carolina.

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Appendix A

Known Shipwrecks Located in the Vicinity of Rehoboth Beach, Sussex County, Delaware

Vessel	Type	Date of Loss	Location	Disposition	Reference
Unknown	Unknown	Unknown	1.25 miles off Rehoboth Beach	Sank	Northern Maritime Research 2002
<i>Faithful Steward</i>	Ship	1785	Indian River Inlet	Aground	Delmar Historical and Art Society 2010
<i>HMS DeBraak</i>	Ship	1798	Delaware Bay	Capsized	Shomette 1993
<i>Samuel D. Wilson</i>	Schooner	1865	12 miles southeast of Cape Henlopen	Collision	The Union 1865
<i>Ellis M. Ridgeway</i>	Schooner	1883	Rehoboth	Ashore	The New York Times 1879
<i>Edward H. Williams</i>	Brig	1885	1 mile northeast of Indian River Life-Saving Station	Ashore	Hurley and Hurley 1984:167
<i>Salmanca</i>	Iron ship	1886	1 mile north of Rehoboth Life-Saving Station	Stranded	The Sun 1887
<i>Uranus</i>	Steamer	1887	Rehoboth	Lost	Cox 1995
<i>Ella</i>	Schooner	1888	1 mile north of Rehoboth Life-Saving Station	Unknown	Northern Maritime Research 2002; Hurley and Hurley 1984:169
<i>Mascotte</i>	Bark	1888	Rehoboth Beach	Unknown	Northern Maritime Research 2002; Hurley and Hurley 1984:169
<i>Emma</i>	Schooner	1888	Rehoboth	Unknown	Northern Maritime Research 2002
Unknown	Schooner	1889	Rehoboth Beach	Ashore	Hurley and Hurley 1984:142
<i>Sarah C. Park</i>	Schooner	1889	2 miles north of Rehoboth Life-Saving Station	Unknown	Northern Maritime Research 2002; Hurley and Hurley 1984:169
<i>Principessa Margherita di Piemonte</i>	Bark	1891	off Cape Henlopen	Sank	Haar 1993
<i>Asphodel</i>	Steamer	1893	.25 miles north of Rehoboth Life-Saving Station	Ashore	The Daily Times 1893
<i>Rhyndland</i>	Steamer	1899	4 miles north of Fenwick's Island Life-Saving Station	Ashore	Youngstown Vindicator 1899
Unknown	Schooner	1903	Rehoboth	At anchor after storm	Boston Evening Transcript 1903.
<i>Hattie A. Marsh</i>	Schooner	1903	Off Rehoboth	Wrecked	The Philadelphia Record 1903
<i>Ira D. Sturgis</i>	Schooner	1906	1.5 miles north of Indian River Life-Saving Station	Ashore	Hurley and Hurley 1984:167
<i>Marie F Cummings</i>	Schooner	1908	1 mile north of Indian River Life-Saving Station	Ashore	Hurley and Hurley 1984:167
<i>Sarah W. Lawrence</i>	Schooner	1909	Hen and Chicken Shoal	Sank	Gentile 1990:196; AWOIS #8132
<i>Sunbury</i>	Unknown	1910	5 miles east of Rehoboth	Unknown	Northern Maritime Research 2002; Hurley and Hurley 1984:169
<i>Merrimac</i>	Schooner	1918	Rehoboth	Stranded	Northern Maritime Research 2002
<i>Sargeant</i>	Barge	1929	Rehoboth Beach	Unknown	Northern Maritime Research 2002; AWOIS #1122
Unnamed	Airplane	1934	Rehoboth Beach	Crashed	The New York Times 1934
<i>Harry K. Fooks</i>	Schooner	1941	4 miles east of Rehoboth Beach	Sank	AWOIS #1125
<i>Thomas Tracy</i>	Freighter	1944	Rehoboth Beach	Aground	Morgan 2004:194; Northern Maritime Research 2002
Unknown	Unknown	1950	Rehoboth Beach	Unknown	Northern Maritime Research 2002

Vessel	Type	Date of Loss	Location	Disposition	Reference
<i>Miss Nottingham</i>	Gas Screw	1962	Rehoboth Beach	Destroyed by storm	Cox 1995
<i>Flo-Mel</i>	Gas Screw Yacht	1964	Rehoboth	Burned	Cox 2001
<i>Hess Hustler</i>	Barge	1968	Rehoboth Beach	Ashore	The Milwaukee Journal 1968
Unknown	Unknown	1968	Rehoboth Beach	Unknown	Northern Maritime Research 2002
Unknown	Unknown	1968	Rehoboth Beach	Unknown	Northern Maritime Research 2002
Unknown	Unknown	1977	Rehoboth Beach	Unknown	Northern Maritime Research 2002
Unknown	Unknown	1977	Rehoboth Beach	Unknown	Northern Maritime Research 2002
<i>Russel W. Peterson</i>	Research Vessel	2008	14 miles from Rehoboth Beach	Foundered	Pearson 2008

Appendix B

Magnetic Anomalies

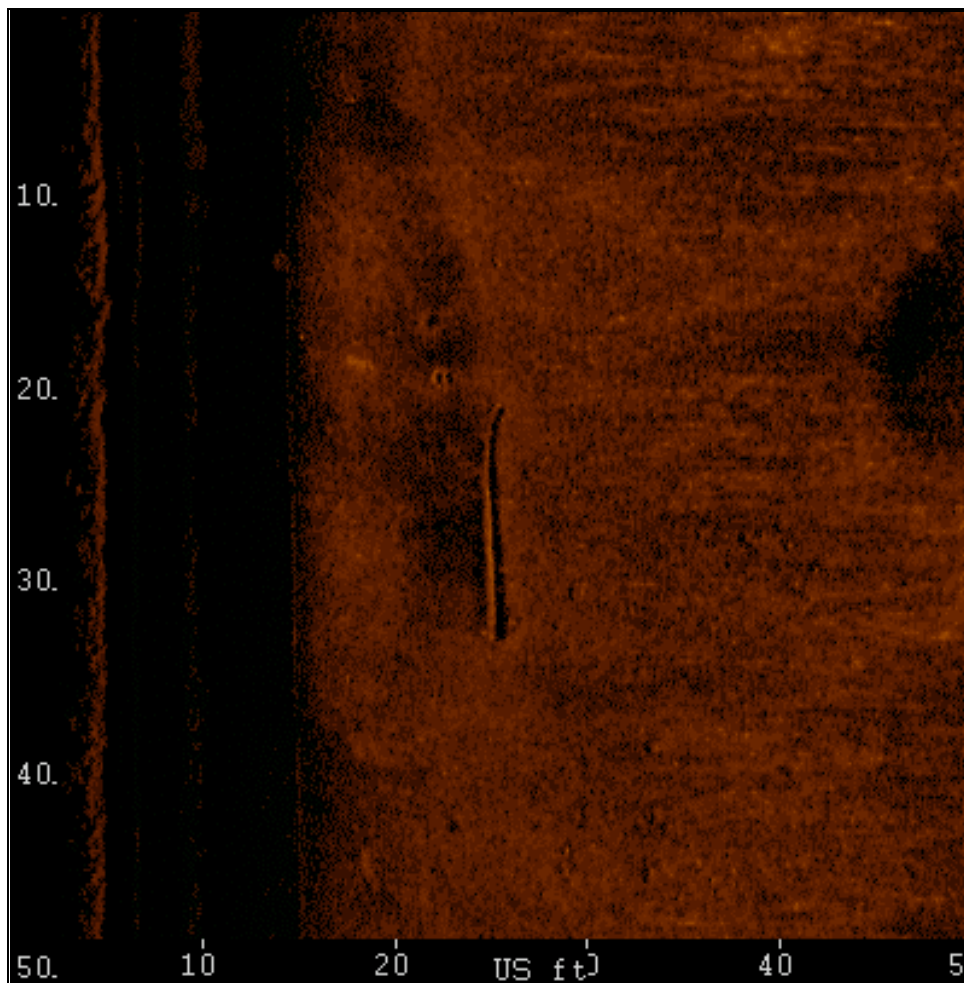
Map Designation	Lane	Number	Characteristics	Intensity (gammas)	Duration (feet)	X	Y	Assessment
M-1	1	1	Positive Monopolar	4	100	757786.0	262705.9	Associated with SS-8
M-2	3	1	Positive Monopolar	4	183	757731.1	262782.6	Associated with SS-7 and SS-8
M-3	4	1	Dipolar	4	205	757745.6	262846.2	Associated with SS-7
M-4	10	1	Multicomponent	5	201	758001.6	263152.0	Associated with a buoy
M-5	19	1	Dipolar	3	108	757782.0	263604.0	Small single object
M-6	32	1	Negative Monopolar	4	120	754536.2	263808.0	Small single object
M-7	40	1	Positive Monopolar	8	51	753569.6	264073.1	Outside survey area
M-8	45	1	Positive Monopolar	7	84	753900.2	264377.4	Small single object
M-9	55	1	Negative Monopolar	1.6	96	758525.9	265526.2	Associated with a buoy
M-10	56	1	Negative Monopolar	2	264	758556.1	265606.2	Associated with a buoy
M-11	57	1	Positive Monopolar	5	92	754480.0	265070.0	Small single object
M-12	58	1	Negative Monopolar	4	75	754464.7	265106.4	Small single object
M-13	60	1	Dipolar	9	120	753658.5	265091.0	Small single object
M-14	61	1	Positive Monopolar	2	220	753695.3	265145.1	Possible small diameter degraded pipe or chain
M-15	62	1	Positive Monopolar	2	177	753684.3	265200.3	Possible small diameter degraded pipe or chain
M-16	63	1	Positive Monopolar	2.6	221	753654.1	265236.3	Possible small diameter degraded pipe or chain

Map Designation	Lane	Number	Characteristics	Intensity (gammas)	Duration (feet)	X	Y	Assessment
M-17	64	1	Positive Monopolar	2.6	306	753675.8	265288.4	Possible small diameter degraded pipe or chain
M-18	65	1	Positive Monopolar	2.3	241	753643.6	265353.6	Possible small diameter degraded pipe or chain
M-19	66	1	Positive Monopolar	1.5	201	753656.6	265393.3	Possible small diameter degraded pipe or chain
M-20	67	1	Positive Monopolar	2	298	753694.7	265453.1	Possible small diameter degraded pipe or chain
M-21	68	1	Positive Monopolar	5	402	753716.0	265503.2	Possible small diameter degraded pipe or chain
M-22	69	1	Positive Monopolar	5	417	753658.6	265556.9	Possible small diameter degraded pipe or chain
M-23	70	1	Positive Monopolar	5	430	753663.6	265597.8	Possible small diameter degraded pipe or chain

Appendix C

Sonar Contacts

SS-1

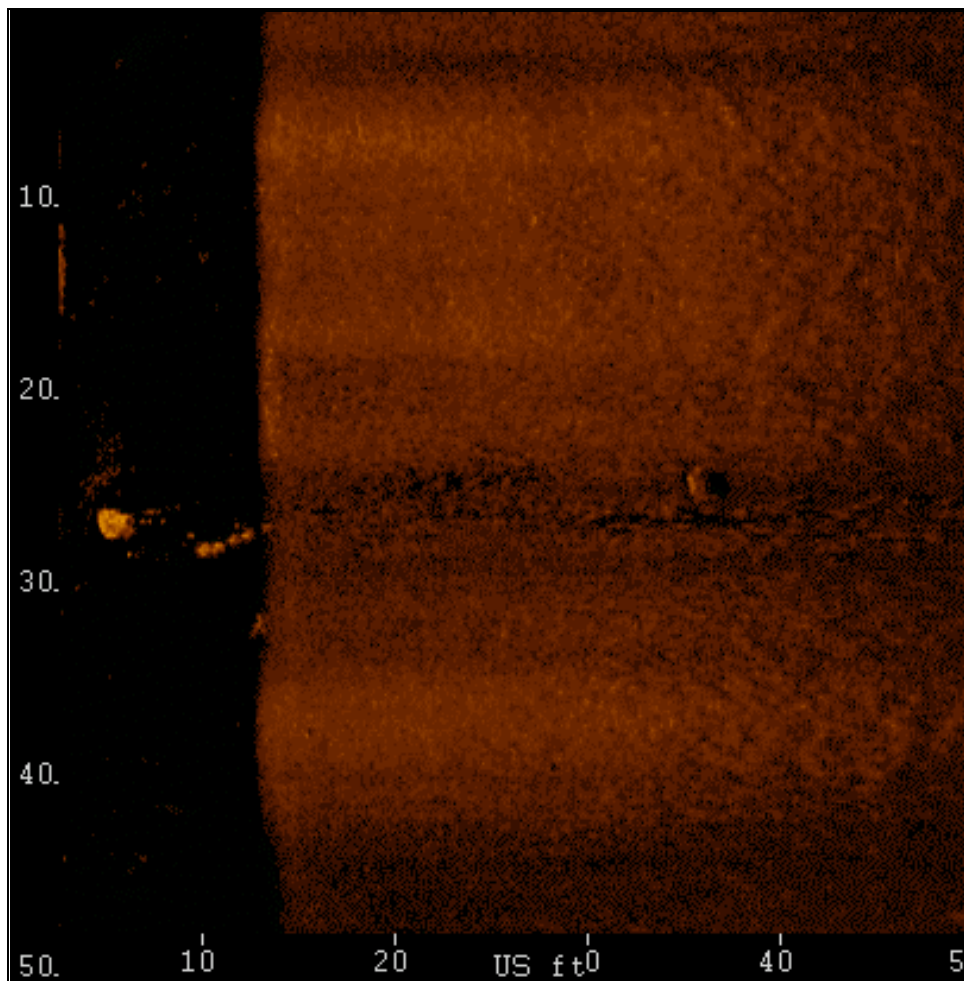
**Contact Info: SS-1**

- Sonar Time at Target: 07/13/2011 20:06:30
- Click Position (Lat/Lon Coordinates)
38.7225494385 -75.0741195679 (WGS84)
- Click Position (Projected Coordinates)
(X) 753899.31 (Y) 263322.38
- Map Proj: DE83F
- Acoustic Source File: RB11_L_23_110713160900.xtf
- Ping Number: 477089
- Range to Target: 17.29 US Feet
- Fish Height: 6.84 US Feet
- Heading: 266.400 degrees
- Line Name: 23

User Entered Info

Target Height: = 0.6 US Feet
 Target Length: 40.4 US Feet
 Target Shadow: 1.6 US Feet
 Target Width: 1.2 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Linear Object

SS-2

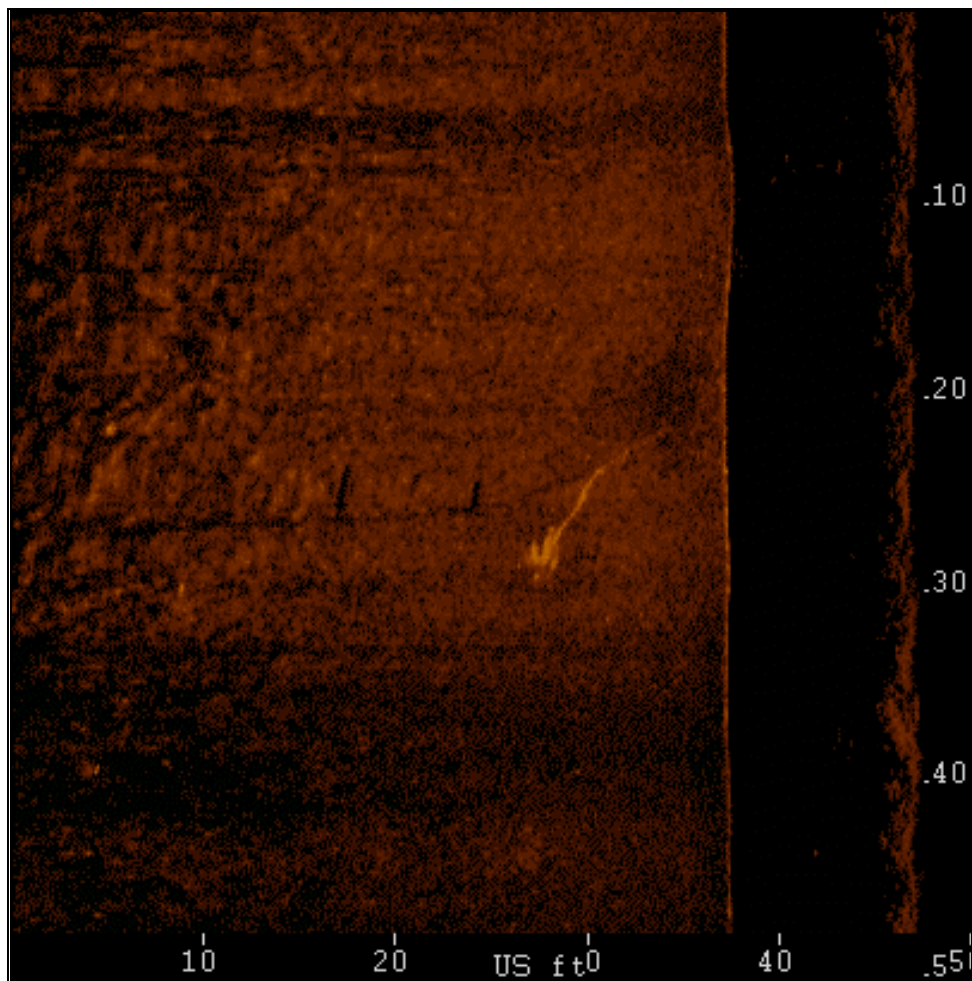
**Contact Info: SS-2**

- Sonar Time at Target: 07/13/2011 12:02:34
- Click Position (Lat/Lon Coordinates)
38.7223358154 -75.0597991943 (WGS84)
- Click Position (Projected Coordinates)
(X) 757985.06 (Y) 263259.03
- Map Proj: DE83F
- Acoustic Source File: RB11_L_10_110713081000.xtf
- Ping Number: 47984
- Range to Target: 35.55 US Feet
- Fish Height: 12.99 US Feet
- Heading: 257.900 degrees
- Line Name: 10

User Entered Info

Target Height: = 0.0 US Feet
 Target Length: 0.0 US Feet
 Target Shadow: 0.0 US Feet
 Target Width: 0.0 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Buoy Mooring

SS-3

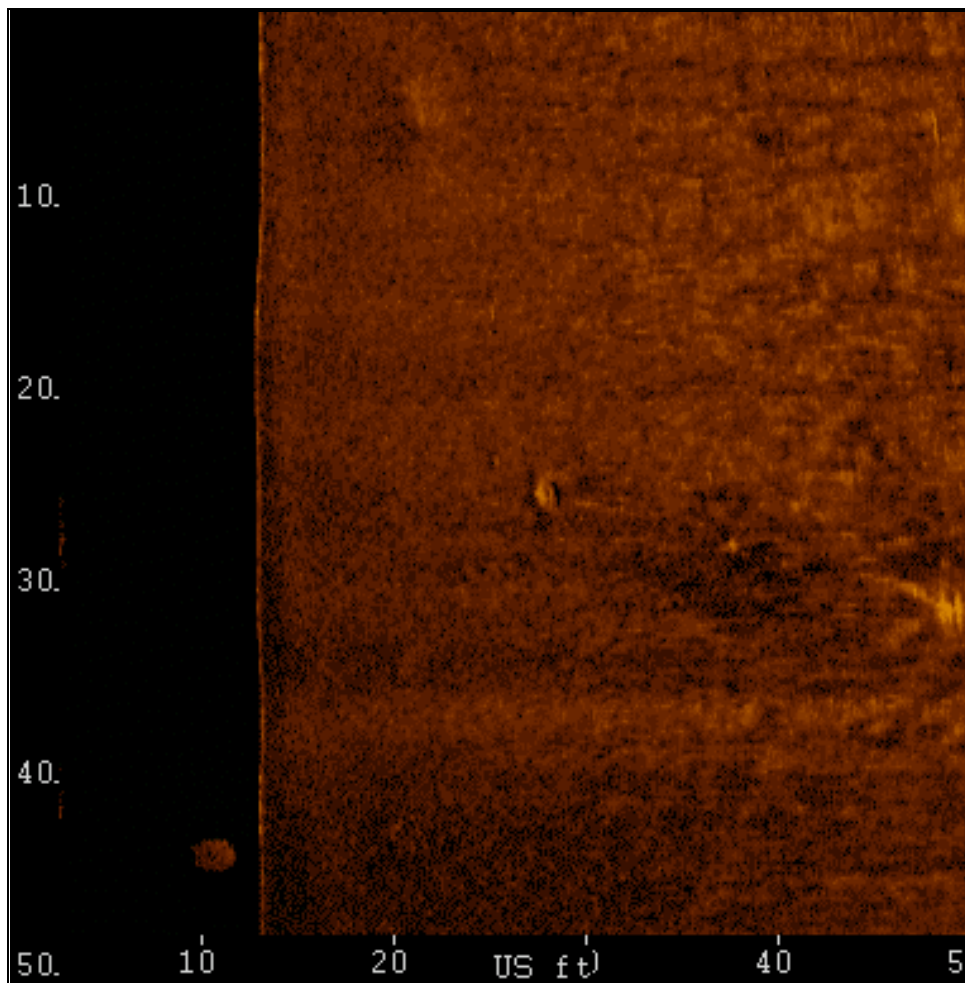
**Contact Info: SS-3**

- Sonar Time at Target: 07/13/2011 21:10:22
- Click Position (Lat/Lon Coordinates)
38.7221908569 -75.0598526001 (WGS84)
- Click Position (Projected Coordinates)
(X) 757970.69 (Y) 263206.50
- Map Proj: DE83F
- Acoustic Source File: RB11_L_09_110713171500.xtf
- Ping Number: 533716
- Range to Target: 25.78 US Feet
- Fish Height: 12.66 US Feet
- Heading: 119.900 degrees
- Line Name: 9

User Entered Info

Target Height: = 0.0 US Feet
 Target Length: 0.0 US Feet
 Target Shadow: 0.0 US Feet
 Target Width: 0.0 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Buoy

SS-4

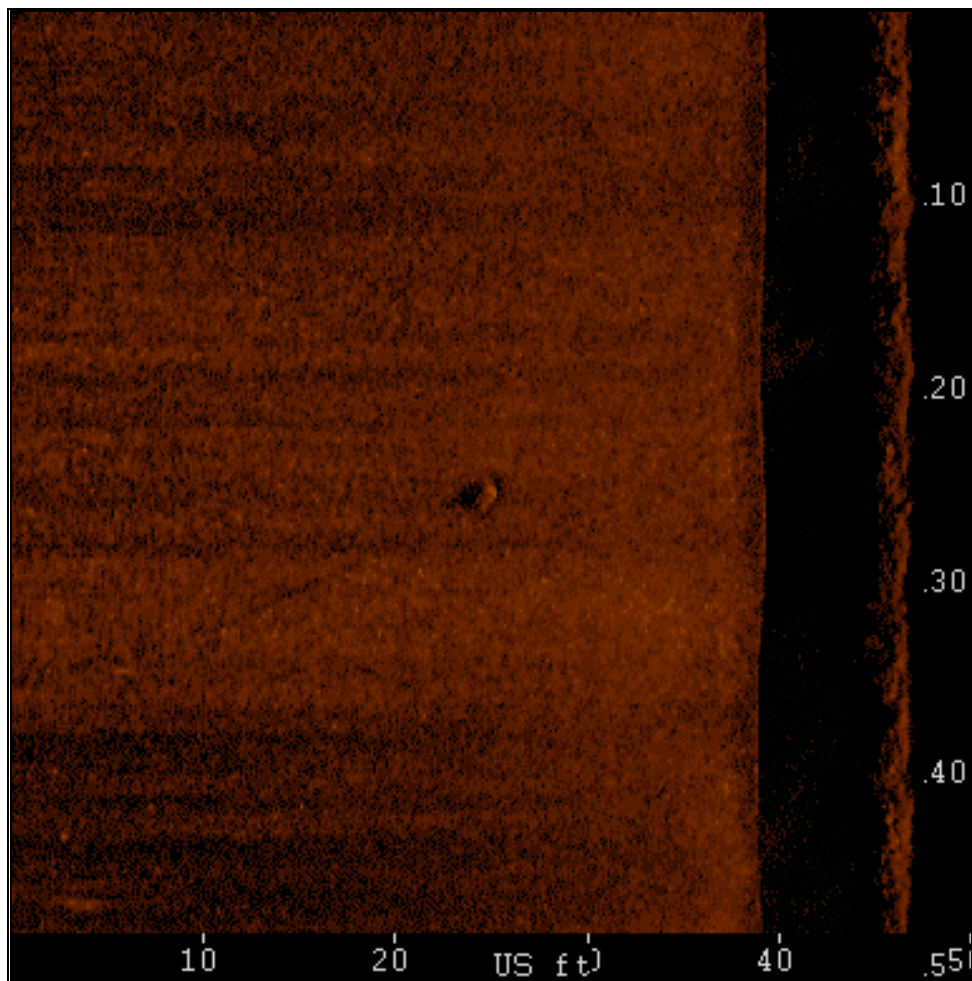
**Contact Info: SS-4**

- Sonar Time at Target: 07/13/2011 21:16:31
- Click Position (Lat/Lon Coordinates)
38.7219390869 -75.0597000122 (WGS84)
- Click Position (Projected Coordinates)
(X) 758015.19 (Y) 263115.59
- Map Proj: DE83F
- Acoustic Source File: RB11_L_07_110713172500.xtf
- Ping Number: 539163
- Range to Target: 27.73 US Feet
- Fish Height: 12.68 US Feet
- Heading: 259.100 degrees
- Line Name: 7

User Entered Info

Target Height: = 0.0 US Feet
 Target Length: 0.0 US Feet
 Target Shadow: 0.0 US Feet
 Target Width: 0.0 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Buoy Mooring

SS-5

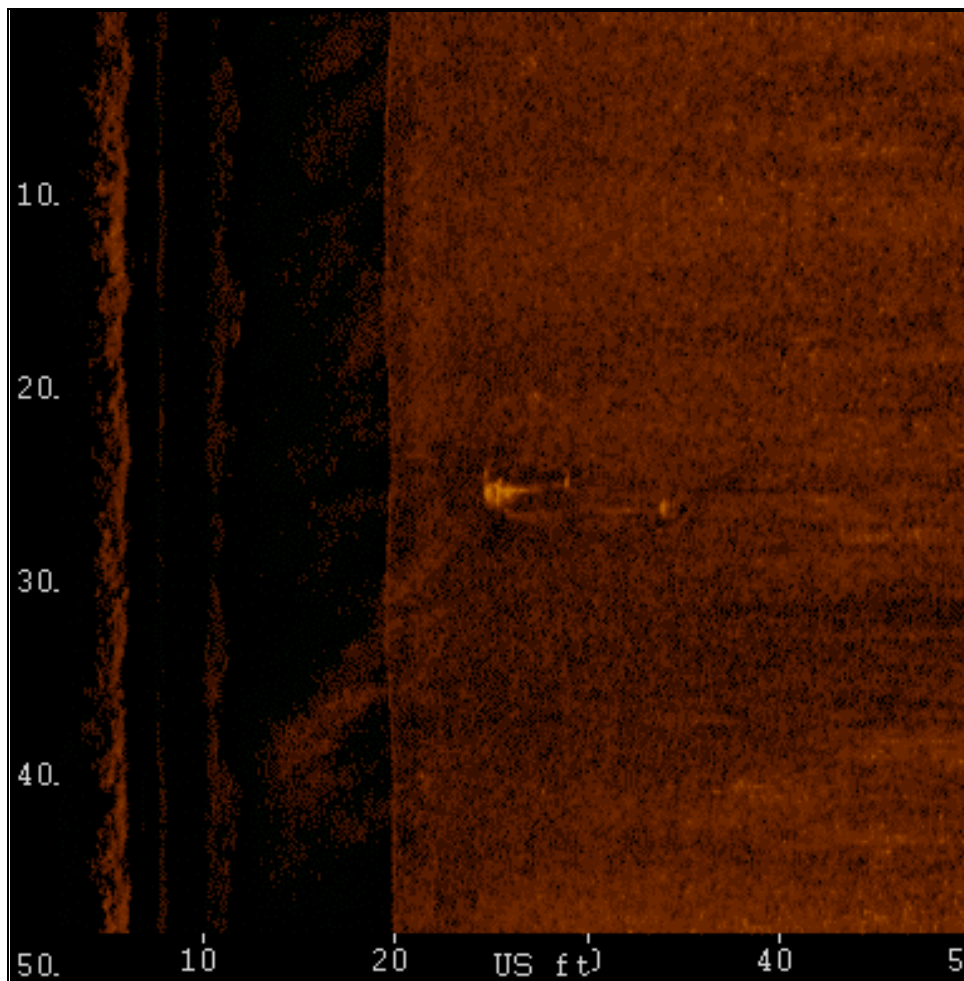
**Contact Info: SS-5**

- Sonar Time at Target: 07/13/2011 17:34:54
- Click Position (Lat/Lon Coordinates)
38.7290153503 -75.0579147339 (WGS84)
- Click Position (Projected Coordinates)
(X) 758513.13 (Y) 265694.09
- Map Proj: DE83F
- Acoustic Source File: RB11_L_57_110713133900.xtf
- Ping Number: 342666
- Range to Target: 24.71 US Feet
- Fish Height: 10.42 US Feet
- Heading: 106.100 degrees
- Line Name: 57

User Entered Info

Target Height: = 0.0 US Feet
 Target Length: 0.0 US Feet
 Target Shadow: 0.0 US Feet
 Target Width: 0.0 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Buoy Mooring

SS-6

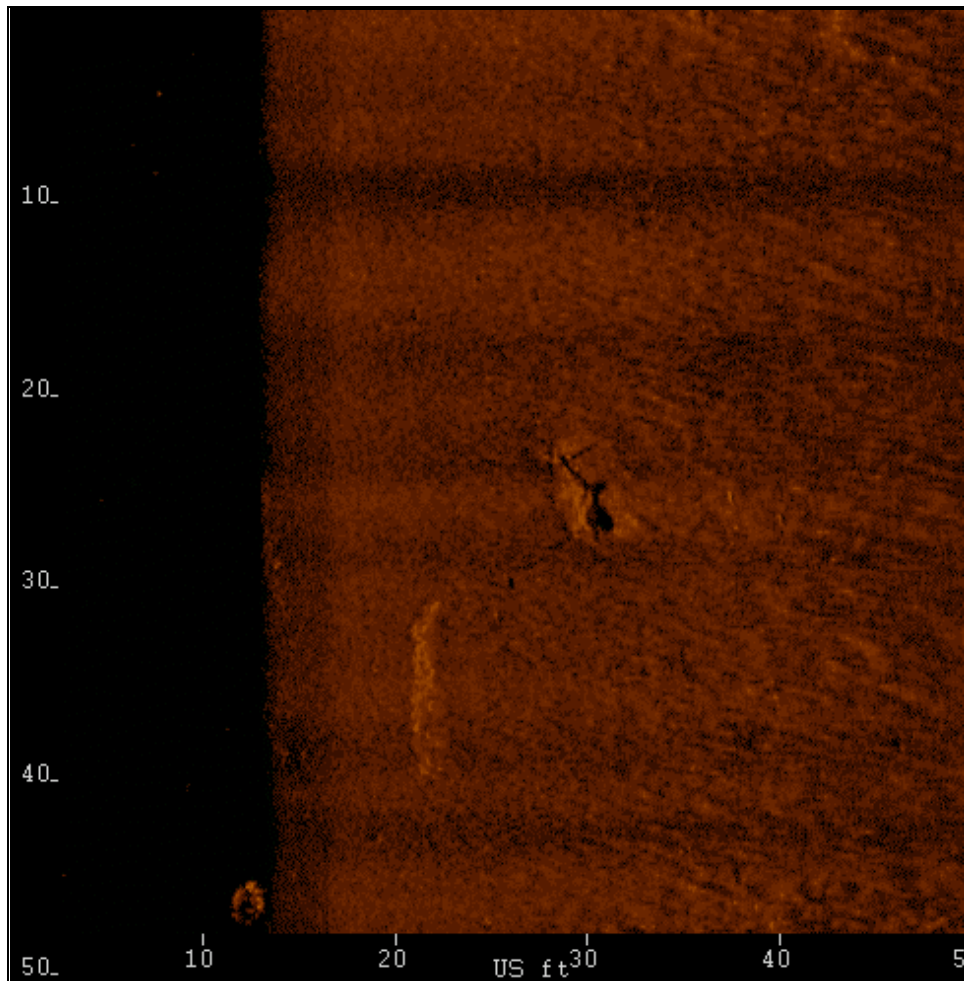
**Contact Info: SS-6**

- Sonar Time at Target: 07/13/2011 17:34:55
- Click Position (Lat/Lon Coordinates)
38.7287063599 -75.0578384399 (WGS84)
- Click Position (Projected Coordinates)
(X) 758536.81 (Y) 265582.91
- Map Proj: DE83F
- Acoustic Source File: RB11_L_57_110713133900.xtf
- Ping Number: 342683
- Range to Target: 16.02 US Feet
- Fish Height: 10.64 US Feet
- Heading: 98.500 degrees
- Line Name: 57

User Entered Info

Target Height: = 0.0 US Feet
 Target Length: 0.0 US Feet
 Target Shadow: 0.0 US Feet
 Target Width: 0.0 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Buoy

SS-7

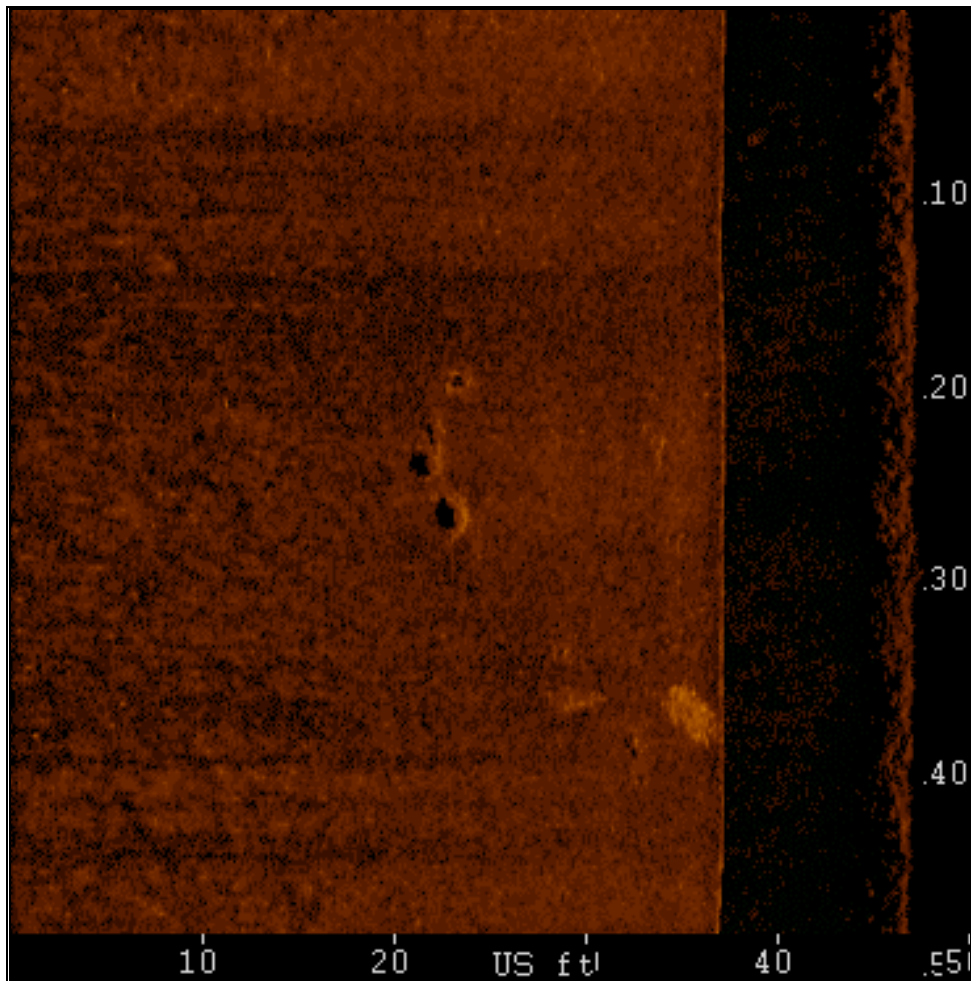
**Contact Info: SS-7**

- Sonar Time at Target: 07/13/2011 11:26:31
- Click Position (Lat/Lon Coordinates)
38.7211647034 -75.0606079102 (WGS84)
- Click Position (Projected Coordinates)
(X) 757757.13 (Y) 262832.97
- Map Proj: DE83F
- Acoustic Source File: RB11_L_02_110713073300.xtf
- Ping Number: 16018
- Range to Target: 29.59 US Feet
- Fish Height: 12.89 US Feet
- Heading: 262.500 degrees
- Line Name: 2

User Entered Info

Target Height: = 1.8 US Feet
 Target Length: 16.5 US Feet
 Target Shadow: 4.4 US Feet
 Target Width: 6.8 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Debris

SS-8

**Contact Info: SS-8**

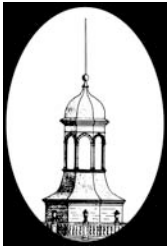
- Sonar Time at Target: 07/13/2011 21:34:42
- Click Position (Lat/Lon Coordinates)
38.7208290100 -75.0605392456 (WGS84)
- Click Position (Projected Coordinates)
(X) 757777.00 (Y) 262710.22
- Map Proj: DE83F
- Acoustic Source File: RB11_L_03_110713174200.xtf
- Ping Number: 555292
- Range to Target: 27.54 US Feet
- Fish Height: 12.89 US Feet
- Heading: 265.000 degrees
- Line Name: 3

User Entered Info

Target Height: = 1.4 US Feet
 Target Length: 28.1 US Feet
 Target Shadow: 3.1 US Feet
 Target Width: 2.7 US Feet
 Mag Anomaly:
 Avoidance Area:
 Classification 1:
 Classification 2:
 Area:
 Block:
 Description: Multiple single objects

Appendix D

Survey Form



DELAWARE STATE HISTORIC PRESERVATION OFFICE
15 THE GREEN, DOVER, DE 19901

CULTURAL RESOURCE SURVEY
ARCHAEOLOGICAL SITE FORM

CRS # _____

Site # _____

Soil Map # _____

1. INFORMANT: Gordon P. Watts, Jr.

2. SURFACE CONDITION: cultivated ☐ wooded ☐ fallow ☐
submerged ☒ marsh ☐ beach/shoreline ☐ urban ☐

other: _____

integrity Unknown

3. SOIL TYPE: Sand

4. DESCRIPTION OF FIELD WORK (check all that apply): surface collection ☐ visibility _____ %

shovel test ☐ measured unit ☐ mechanical stripping ☐

remote sensing ☒ walkover ☐ informant collection ☐

5. COLLECTIONS:

a) Repository None Accession # _____

Collector/consultant None

Date _____ Surface ☐ Excavation ☐

b) Repository _____ Accession # _____

Collector/consultant _____

Date _____ Surface ☐ Excavation ☐

c) Repository _____ Accession # _____

Collector/consultant _____

Date _____ Surface ☐ Excavation ☐

d) Repository _____ Accession # _____

Collector/consultant _____

Date _____ Surface ☐ Excavation ☐

6. ARTIFACTS: List material and types

CRS #	
Site #	

None

7. FEATURES:

A scatter of debris visible in the side scan sonar data.

8. DOCUMENTATION:

Publication/report title	Year
Archaeological Remote-Sensing Survey of a Proposed Pipeline Area Offshore of Rehoboth Beach, Sussex County Delaware	2011

Supporting documentation on file: (Mark the appropriate boxes)

Field notes	yes <input type="checkbox"/>	no <input checked="" type="checkbox"/>
Maps	yes <input checked="" type="checkbox"/>	no <input type="checkbox"/>
Drawings	yes <input type="checkbox"/>	no <input checked="" type="checkbox"/>
Photographs	yes <input type="checkbox"/>	no <input checked="" type="checkbox"/>
Lab Analysis	yes <input type="checkbox"/>	no <input checked="" type="checkbox"/>

Other: Remote-sensing data

USE BLACK INK ONLY

Appendix E

Scope of Work

ORIGINAL

CLIENTS | PEOPLE | PERFORMANCE

June 16, 2011

Mr. Gordon P. Watts, Jr.
Tidewater Atlantic Research, Inc.
5290 River Road
P.O. Box 2494
Washington, NC 27889

Re: Rehoboth Beach Ocean Outfall
Underwater Archaeological Survey (Task Order 3.2)
City of Rehoboth Beach, DE
GHD No. 861432700.14

Dear Mr. Watts:

This letter and the attached Standard Conditions will serve as an Agreement between Stearns & Wheeler GHD (ENGINEER) and Tidewater Atlantic Research, Inc. (CONSULTANT) for services on the above-referenced project.

ENGINEER has made an agreement dated May 6, 2010, with the City of Rehoboth Beach, Delaware (OWNER), which is herein referred to as the Prime Agreement and which provides for ENGINEER's performing professional services in connection with the Project described therein. The title of the Project described in the Prime Agreement is Rehoboth Beach Ocean Outfall Project.

SCOPE OF SERVICES

CONSULTANT will provide Basic Services as outlined below:

A. Background Research

Gather all relevant secondary and readily available primary source material on the prehistory and history of the project area. This includes a check of the Delaware Cultural Resource Survey (CRS) Inventory and National Register files to identify the known cultural resources in the project area. Enough material must be gathered to allow the surveyor to identify the historic contexts that will most likely be encountered in the area and on which a preliminary research design can be based.

B. Surveying

Perform side scan sonar (acoustic) and magnetic remote sensing in the survey area to determine the presence or absence of submerged cultural resources potentially eligible for the National Register of Historic Places. Surveying shall meet the following requirements:

B1. Survey lanes

Survey lanes shall be no more than 50 feet wide, and spacing will be coordinated with the limitations of the equipment utilized to ensure full coverage within the survey area.

B2. Magnetic remote surveying

Magnetic remote sensing data shall be recorded with a magnetometer capable of +/- one gamma resolution. At minimum, magnetic sampling shall be performed at intervals of 5 feet along the survey lanes.

Mr. Gordon P. Watts, Jr.
 Tidewater Atlantic Research, Inc.
 June 16, 2011
 Page 2

B3. Side scan sonar

Side scan sonar (acoustic) remote sensing data shall be recorded by a two-channel digital acoustic recorder with frequency of 300 kHz at minimum.

B4. Survey Extents

Acoustic and magnetic remote sensing shall be performed in the area delineated in Attachments 1 and 2. The four-sided area is defined by corners at the Latitude and Longitude coordinate:

	WGS84 GPS Coordinates	
Northwest corner	38° 43' 43.068" N	75° 4' 32.125" W
Northeast corner	38° 43' 51.808" N	75° 3' 15.144" W
Southwest corner	38° 43' 9.140" N	75° 4' 25.223" W
Southeast corner	38° 43' 17.885" N	75° 3' 8.607" W

C. Data Analysis and Reporting

C1. Magnetic data

Magnetic data shall be contour plotted and anomalies analyzed according to:

- Magnetic intensity
- Pulse duration
- Signature characteristics
- Spatial extent

C2. Acoustic data

Acoustic data anomalies shall be analyzed according to:

- Spatial extent
- Configuration
- Location
- Environmental context

C3. Data Coordination

Magnetic and acoustic targets shall be correlated to provide additional information on the composition of the target.

C4. Data Presentation

GPS coordinates and descriptions of all magnetic and acoustic anomalies shall be provided. Targets that are suggestive of potentially significant submerged cultural resources shall be identified as such. The criteria used to determine which targets are suggestive of potentially significant submerged cultural resources shall be stated.

Appendix F

Professional Qualifications

PROFESSIONAL RÉSUMÉ

NAME Gordon P. Watts, Jr.

ADDRESS Post Office Box 2494
Washington, NC 27889

TELEPHONE Voice 252.975.6659
FAX 252.975.2828

CURRENT POSITIONS

DIRECTOR: Tidewater Atlantic Research, Inc. [TAR]
P. O. Box 2494
Washington, North Carolina 27889

DIRECTOR: Institute for International Maritime Research, Inc. [I²MR]
P. O. Box 2489
Washington, North Carolina 27889

EDUCATIONAL BACKGROUND

1968 B.A. History, East Carolina University
1975 M.A. History, East Carolina University
1997 Ph.D. Maritime History and Underwater Archaeology
University of St. Andrews, Fife, Scotland

EMPLOYMENT HISTORY

1979 TO CURRENT DATE

DIRECTOR, TIDEWATER ATLANTIC RESEARCH, WASHINGTON NC

Tidewater Atlantic Research was formed in July 1979 to provide historical and archaeological research and cultural resource management services to state and federal agencies, institutions, corporations, and organizations requiring specialized skills. To provide the most appropriate combination of skills and experience, project staffs are organized on an individual basis selecting personnel from a nucleus group with professional backgrounds in underwater prehistoric and historic archaeology, historical research and writing, cultural resource location, identification, assessment, management, and mitigation. Research associate staff experience includes expertise in both acoustic and magnetic remote sensing, self contained and surface supplied compressed air and mixed gas diving operations, underwater photographic and closed circuit television documentation, remote operated vehicle piloting, and artifact analysis and conservation.

Under Dr. Watts's direction, TAR has carried out survey and assessment operations for a variety of local, state, and Federal agencies, including the United States Navy, U.S. Army Engineer District, Wilmington; U.S. Army Engineer District, Philadelphia; U.S. Army Engineer District, Baltimore; U.S. Army Engineer District, Charleston; U. S. Army Engineer District, Jacksonville, South Carolina Department of Highways and Public Transportation; Georgia Department of Transportation, North Carolina Department of Transportation, Virginia Department of Transportation, Maryland Department of Transportation, Florida Department of Transportation, University of South Carolina Institute of Archaeology and Anthropology; Norfolk, Virginia Port Authority; City of Alexandria, Virginia; City of Sheboygan, Wisconsin; City of Milwaukee Wisconsin; Maryland Geological Survey; Virginia Historic Landmarks Commission; Delaware Division of Soil and Water Conservation; Confederate

Naval Museum, the Baldwin County Alabama Archaeological Advisory Review Board, Bermuda Maritime Museum, Museum of Art and Culture, Trinidad/Tobago, and numerous other firms, agencies, museums, and institutions.

1993 TO CURRENT DATE

DIRECTOR, INSTITUTE FOR INTERNATIONAL MARITIME RESEARCH, WASHINGTON NC

The Institute for International Maritime Research was formed in 1993 to conduct and sponsor maritime, historical and underwater research. It provides a not-for-profit outlet for channeling grants, gifts and in kind support into marine surveys and underwater research related to shipwrecks and submerged cultural resources of historical and archaeological interest. One of the specific objectives of the Institute is to promote the teaching of marine and archaeological skills to students and avocational divers and promote the dissemination of both professional and public information pertaining to maritime research. Dr. Watts was elected chairman of the board of directors in January 1994 and has since that time been responsible for the conduct of research and educational activities of the organization.

Research activities of the Institute include supporting student thesis research in North Carolina on the remains of Shell Castle, an 18th and 19th century trading station in the Pamlico Sound near Ocracoke Island, an on-going search for one of the Spanish shipwrecks of the 1750 Plate Fleet, a survey of the shipwreck and derelict vessels associated with the port town of Washington, North Carolina, an investigation of the remains of the Civil War shipwreck USS *Peterhoff* and a remote sensing survey of the remains of an 18th century shipwreck tentatively identified as the *Queen Anne's Revenge* lost by the pirate Blackbeard. One of the most unique projects undertaken by the Institute has been the restoration of the North Carolina built skipjack *Ada Mae*. That unique vessel was found in Baltimore and brought back to North Carolina for restoration that is currently underway. In conjunction with the National Oceanic and Atmospheric Administration, the Institute has developed an in-site Geographical Information System for the USS *Monitor* and is working on a similar system for Bermuda shipwreck resources for the Bermuda Maritime Museum and U. S. Navy shipwrecks in Virginia and Georgia waters for the Naval Historical Center. The Institute is also working in conjunction with the Naval Historical Center and the CSS *Alabama* Association on investigation of the remains of that celebrated Confederate commerce raider.

1981 TO 1 JANUARY 2001

PROFESSOR, MARITIME HISTORY AND NAUTICAL ARCHAEOLOGY, DEPARTMENT OF HISTORY, EAST CAROLINA UNIVERSITY

In 1981, Dr. Watts joined Dr. William N. Still at East Carolina University to design and develop the Program in Maritime History and Underwater Research. The program designed by Watts and Still was established to provide graduate opportunities for students interested in maritime history and underwater archaeology. The program includes both academic and field research. Traditional and maritime histories support the program to provide a context for underwater archaeology. Students enrolled in the program participated in a summer field school in Maritime History and Underwater Archaeology and a fall research semester designed to provide field experience on a variety of research projects involving site location, identification, testing, and excavation.

Dr. Watts supervised and directed numerous grant and university-supported field research projects. Those investigations included remote sensing and archaeological investigations of Colonial ports in North Carolina, early ferry crossings in both North Carolina and South Carolina, shipwrecks sites in North Carolina, South Carolina, Virginia, Georgia, Pennsylvania, Florida, Alabama, Wisconsin, Michigan, Minnesota and Virginia. Dr. Watts worked with the Bermuda Maritime Museum to investigate a number of 16th, 17th, 18th and 19th century shipwrecks. In association with the Institute of Nautical Archaeology at Texas A&M University, additional research projects were carried out in Jamaica, Panama, Dominican Republic and Mexico. In conjunction with other agencies and

organizations project organization, development and research activities included work on the USS *Monitor* in conjunction with NOAA, development of a planning document for the War of 1812 schooners *Hamilton* and *Scourge* in conjunction with the Ontario Heritage Foundation, surveys of Civil War shipwrecks in Mobile Bay and off Fort Fisher, North Carolina for the National Park Service, documentation of the Confederate ironclads CSS *Jackson* for the Confederate Naval Museum, the CSS *Neuse* for the North Carolina Division of Archives and History and investigation of the CSS *Alabama* with the Naval Historical Center and Association CSS *Alabama* in France.

1978-1981

HEAD, UNDERWATER ARCHAEOLOGY BRANCH, NORTH CAROLINA DIVISION OF ARCHIVES AND HISTORY

In February 1978, the Underwater Archaeology Branch was created to manage North Carolina's submerged cultural resources. Under the direction of Dr. Watts, program activities included development of a "State Resource Management Plan," survey and planning, grant development, environmental review, education (public and academic), contract administration, public information, preservation, and historic and archaeological research. In addition to activities related to submerged cultural resources management, the UAB cooperated with NOAA to develop management programs and conduct on-site research in the USS *Monitor* National Marine Sanctuary.

1972-1978

UNDERWATER ARCHAEOLOGIST, NORTH CAROLINA DIVISION OF ARCHIVES AND HISTORY

In 1972, the North Carolina Division of Archives and History reorganized its program in underwater archaeology. Dr. Watts worked to expand the program to focus on a "state-wide" approach to the identification and investigation of underwater archaeological resources. Through increased public participation, more sophisticated educational activities and an improved Salvage Contract Program, activities of the UAB were dramatically expanded. Through cooperative programs with Cape Fear Technical Institute and the University of North Carolina at Wilmington, students were offered the opportunity to assist with historical research, survey and site assessment investigations.

1971-1972

UNDERWATER ARCHAEOLOGICAL FIELD AGENT, FLORIDA DIVISION OF ARCHIVES, HISTORY AND RECORDS MANAGEMENT

In 1971 Watts accepted a position with the Florida Division of ArchivesHistory and Records Management. Under the direction of State Underwater Archaeologist Carl Clausen, Watts served as a field director for the first Early Man investigations at Little Salt Spring and Warm Mineral Spring. Those investigations uncovered the first inundated evidence of human habitation in Florida dating as early as 14,500 BP. Extensive human skeletal remains were recovered from undisturbed contexts in association with extinct mega fauna such as sloth, mastodon and giant tortoise. Watts also worked in the Florida Keys documenting the West Turtle Shoals Site, one of the earliest shipwrecks in North America.

PARTIAL LISTING OF MEMBERSHIPS [CURRENT AND PAST]

First Colony Foundation, Chapel Hill, North Carolina
Waitt Institute for Discovery [Advisory Committee]
CSS *Alabama* Association, Mobile, Alabama [Board of Directors]
Association CSS *Alabama*, Paris, France [Board of Directors]
St. Augustine Lighthouse & Museum [Board of Trustees]
Maritime Archaeological and Historical Society [Board of Advisors]

Carolina Coastal Classrooms
 Coastal Heritage Society [Georgia]
 Institute of Nautical Archaeology [Adjunct Professor]
Monitor National Marine Sanctuary Archaeological
 Documentation Committee
 Steamship Historical Society of America
 Advisory Council on Underwater Archaeology
 Institute of Maritime History and Archaeology [Bermuda
 Maritime Museum]
 Institute of Maritime History [Philadelphia Maritime Museum]
 The Society for Georgia Archaeology
Hamilton/Scourge Project [Technical Advisory Team]
 Society for Historical Archaeology
 Society for Historians in Eastern North Carolina
 North American Society for Oceanic History
 Cape Fear Technical Institute Marine Advisory Committee
 North Carolina Archaeological Council
 Maritime Heritage Preservation Task Force

PUBLICATIONS AND REPORTS [PARTIAL]

Watts, Gordon P., Jr., and Leslie S. Bright

- 1973 Progress in Underwater Archaeology in North Carolina: 1962-72. *International Journal of Nautical Archaeology*.

Watts, Gordon P., Jr., and John G. Newton

- 1974 The Role of Archival Records in the Location and Identification of the *Monitor*. *Proceedings of the National Archives Conference on Naval History*, Washington: National Archives.
- 1975 De *Monitor* Gelokaliseerd. *Speigal Historiae*, 10.
- 1975 Location and Identification of the Ironclad USS *Monitor*. *International Journal of Underwater Archaeology and Underwater Exploration*, Vol. 4, No. 2.
- 1976 An Investigation of Two Revolutionary War Wrecks in the Mullica River at Chestnut Neck. Report to the New Jersey State Museum.
- 1977 Underwater Archaeology: A Brief Insight. *Man and The Sea Conference Proceedings*, Philadelphia: Temple University.

Watts, Gordon P., Jr., et al.

- 1977 Preliminary Report: Stereo Photography and Artifact Retrieval, 16 July-2 August, 1977, *Monitor* Marine Sanctuary. Washington D.C.: NOAA.
- 1978 The Fort Branch Survey and Recovery Project. Beneath the Waters of Time, *Proceeding of the Ninth Conference on Underwater Archaeology*. Austin, Texas Antiquities Committee.

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- 1978 *The MONITOR: A Bibliography*, Raleigh, North Carolina Division of Archives and History.

- Watts, Gordon P., Jr.
 1979 Magnetic Analysis: A Useful Tool for Development Planning and Investigation on Historic Sites. Proceedings from the Conference on Historic Sites. *Archaeology*, Columbia, South Carolina, Institute of Archaeology and Anthropology.
- Watts, Gordon P., Jr., et al.
 1979 "The Fort Branch Survey and Recovery Project". Raleigh, North Carolina. Division of Archives and History.
- Watts, Gordon P., Jr.
 1980 Hydraulic Probing: One Solution to Overburden and Environment. *International Journal of Nautical Archaeology*.
- 1980 Submerged Cultural Resource Survey and Assessment of the Mark Clark Expressway Wando River Corridor Charleston and Berkeley Counties South Carolina. Wilmington, N.C., Tidewater Atlantic Research.
- 1981 The Edenton Harbor Wrecks: Underwater Archaeology in America. *Archaeology*, Vol.34, Number 3, May/June.
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 1981 "Excavation of a Fort Fisher Bombproof". Raleigh, North Carolina Division of Archives and History.
- Watts, Gordon P., Jr., Editor
 1981 Underwater Archaeology: The Challenge Before Us, *Proceedings on the Twelfth Conference on Underwater Archaeology*, San Marino, California: Fathom Eight Corporation
- 1982 Investigating the Remains of the U.S.S. *Monitor*: A Final Report on 1979 Site Testing in the *Monitor* National Marine Sanctuary. Raleigh: North Carolina Division of Archives and History.
- Watts, Gordon P., Jr., et al.
 1982 "A Reconnaissance Survey of the Chattahoochee River at Columbus, Georgia". Washington, North Carolina, Tidewater Atlantic Research.
- Watts, Gordon P., Jr., et al.
 1982 "Fort Fisher: An Archaeological Survey and Evaluation at Fort Fisher State Historic Site and Vicinity". North Carolina Division of Archives and History, Raleigh, North Carolina.
- Watts, Gordon P., Jr., and Wilson Angley
 1984 Beaufort County's City Beneath the Sea. *Beaufort County Magazine*, Williams Company, Inc., Washington, North Carolina.
- Watts, Gordon P., Jr.
 1985 Investigating Historic Blossom's Ferry, North Carolina. *Archaeology*, Vol. 38, No. 5, pp. 26-33.
- 1985 Deep-Water Archaeological Investigation and Site Testing in the MONITOR National Marine Sanctuary. *Journal of Field Archaeology*, Vol. 12, pp. 315-332.
- 1985 "Towards Establishing Research and Significance Criteria for Civil War Shipwreck Resources." *Proceedings of the Sixteenth Conference on Underwater Archaeology*. Ed. Paul F. Johnston, Special Publication Series, No.4, The Society for Historical Archaeology, Ann Arbor, Michigan.

- Watts, Gordon P., Jr., et al.
 1986 Bermuda Shipwrecks and the American Civil War. *Ratlines*, Bermuda Maritime Museum, Somerset, Bermuda.
- Watts, Gordon P., Jr., and Wesley K. Hall
 1986 An Investigation of Blossom's Ferry on the Northeast Cape Fear River, Department of History, East Carolina University, Research Report No. 1.
- Watts, Gordon P., Jr., et al.
 1987 A Report on 1983 Investigations in the USS *Monitor* National Marine Sanctuary, Department of History, East Carolina University, Greenville, North Carolina.
- Watts, Gordon P., Jr.
 1987 A Decade of Research: Investigation of the USS *Monitor*. A paper prepared and presented at the SHA/CUA meeting in Savannah, Georgia to be published in the *Proceedings of the Society for Historical Archaeology*, Columbia, South Carolina, 1988.
- Watts, Gordon P., Jr.
 1988 The Civil War at Sea: Dawn of an Age of Iron and Engineering. *Ships and Shipwrecks of the Americas*, George F. Bass, Editor., Thames and Hudson, New York and London, 1988.
- Watts, Gordon P., Jr.
 1988 Bermuda in the American Civil War: A Reconnaissance Investigation of Archival and Submerged Cultural Resources. *International Journal of Nautical Archaeology*, Vol. 1988.
- Watts, Gordon P., Jr.
 1988 "A Decade of Research: Investigating the USS *Monitor*." *Underwater Archaeology Proceedings from the Society of Historical Archaeology Conference*. Ed. Alan B. Albright, The Society for Historical Archaeology, Ann Arbor, Michigan.
- Watts, Gordon P., Jr.
 1989 The Sinkentine: A Fiberglass Shipwreck Model to Assist in Teaching Three Dimensional Mapping. *International Journal of Nautical Archaeology*, Vol. 18.2: pp.151-156.
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 1989 "Runners of the Union Blockade." *Archaeology*, Vol. 42, No.5, September/October: pp. 32-39.
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 1990 "CSS *Alabama*: Controversial as Always, Yet Offering Opportunities for International Cooperation." *Underwater Archaeology Proceedings from the Society for Historical Archaeology Conference*. Ed. Toni L. Carrell, Society for Historical Archaeology, Tucson, Arizona.
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 1990 CSS *Chattahoochee*: An Investigation of the Remains of a Confederate Gunboat. East Carolina University, Greenville, North Carolina.
- Watts, Gordon P., Jr., et al.
 1991 The 1987 Expedition to the Monitor National Marine Sanctuary: Data Analysis and Final Report. Sanctuaries and Reserves Division, National Oceanic and Atmospheric Administration, Washington, D. C.

- Watts, Gordon P., Jr., Megan A. Partlow, Bradley A. Rogers, and Gregory T. Smith
1991 By Fire, Storm, and Ice: Underwater Archaeological Investigations in the Apostle Islands. Ed. David J. Cooper. State Historical Society of Wisconsin, Madison, Wisconsin.
- Watts, Gordon P., Jr.
1992 Identification and Assessment of Light Vessel Number 57, South Shore Park, Milwaukee, Wisconsin. *The Wisconsin Archaeologist*. 73(1-2):11-60.
- Watts, Gordon P., Jr.
1993 "The Western Ledge Reef Wreck: A Preliminary Report on Investigation of the Remains of a 16th-Century Shipwreck in Bermuda." *International Journal of Nautical Archaeology* 22:103-124.
- Watts, Gordon P., Jr.
1993 "A Decade of Shipwreck Research in Bermuda." *Bermuda Journal of Archaeology and Maritime History* 5:12-57.
- Watts, Gordon P., Jr., et al.
1993 "Steam Navigation and the United States," Chapter in *The Advent of Steam: The Merchant Steamship before 1900*. Edited by Robert Gariner.
- Watts, Gordon P., Jr., John Broadwater, John W. Morris, and Marianne Franklin
1994 Final Report on IMHA-3: A Sixteenth-Century Spanish Wreck Off Bermuda. Paper Presented at the Annual Meeting of the Society for Historical Archaeology Conference on Historical and Underwater Archaeology, Vancouver, Canada.
- Watts, Gordon P. Jr., John W. Morris and Marianne Franklin
1995 "The Comparative Analysis of 18th-Century Vessel Remains in the Archaeological Record: A Synthesized Theory of Framing Evolution". Proceedings from the Conference on Underwater Archaeology in Washington, D.C. Society for Historical Archaeology.
- Watts, Gordon P. Jr., and Michael Cameron Krivor
1995 "Investigation of an 18th-century English shipwreck in Bermuda." *The International Journal of Nautical Archaeology*. 24:2.
- Watts, Gordon P., John C. Neville and Ian Roderick Mather
1996 "Raising Standards: A Modern Framework for Protecting Our Common Maritime Heritage." *Common Ground*. 1: No. 3/4:16-23, Fall/Winter 1996.
- Watts, Gordon P., and Ian Roderick Mather
1998 "Geographic Information Systems for Submerged Cultural Resource Management and Site Specific Investigation" Proceedings from the Conference on Underwater Archaeology in Atlanta, Georgia. Society for Historical Archaeology.
- Watts, Gordon P., and Ian Roderick Mather
1998 "Underwater Archaeological Investigation of the Remains of the Ironclad CSS *North Carolina*." Proceedings from the Conference on Underwater Archaeology in Atlanta, Georgia. Society for Historical Archaeology.
- Watts, Gordon P., and Ian Roderick Mather
2002 "GIS: A New Tool for Underwater Archaeologists and Submerged Cultural Resource Managers." Chapter published in Plenum Press volume *International Handbook on Underwater Archaeology*.

Watts, Gordon P., and Ian Roderick Mather

- 2002 "Ethics in Underwater Archaeology" Chapter published in Plenum Press volume *International Handbook on Underwater Archaeology*.

Watts, Gordon P., Jr., et al.

- 2003 "A Historic Resources Protection Plan and Geographic Information System for Shipwrecks in Virginia Waters Under the Jurisdiction of the United States Navy." Produced for the Naval Historical Center, Washington Navy Yard, Washington, DC.

Watts, Gordon P., Jr.

- 2004 "Archaeological Investigation and Remote Operated Vehicle Documentation: Confederate Commerce Raider CSS Alabama 2002." Report to the Naval Historical Center and the French Ministry of Culture. Institute for International Maritime Research, Inc., Washington, North Carolina.

Watts, Gordon P., Jr.

- 2004 "A Second Decade of Shipwreck Research in Bermuda." *Bermuda Journal of Archaeology and Maritime History* 14:61-147.

Watts, Gordon P., Jr., et.al.

- 2004 *Archaeological Damage from Offshore Dredging: Recommendations for Pre-Operational Surveys and Mitigation During Dredging to Avoid Adverse Impacts*. OCS Report MMS2004-005. Prepared for: Leasing Division, Sand and Gravel Unit, Minerals Management Service, U.S. Department of Interior. Herndon, Virginia.

Watts, Gordon P., Jr., Ian Roderick Mather and Raymond Tubby

- 2005 Archaeological Documentation of the Remains of a Late Eighteenth-or Early Nineteenth-Century Vessel Located in the Elizabeth River Ferry Docking Facility, City of Portsmouth, Virginia. Special Publication, Virginia Department of Historic Resources, Richmond, Virginia.

Watts, Gordon P., Jr., Ian Roderick Mather and Raymond Tubby

- 2006 "Portsmouth Shipwreck (44MP52) Archaeological Documentation of the Remains of a Late Eighteenth-or Early Nineteenth-Century Vessel Located in the Elizabeth River Ferry Docking Facility, City of Portsmouth, Virginia." *Technical Report Series No. 6.*, Virginia Department of Historic Resources. Richmond, Virginia.

Watts, Gordon P., Jr. and T. Kurt Knoerl

- 2007 "Entering the Virtual World of Underwater Archaeology." *Out of the Blue: Public Interpretation of Maritime Cultural Resources*. Springer Science, New York.

Watts, Gordon P., Jr.

- 2009 "An Overview of Archaeology Under Virginia Waters." To be published in 2010 *Virginia Notes*. Published by Virginia Department of Historic Resources. Richmond, Virginia.

Recent Submerged Cultural Resource Survey Reports Completed in 2009

Watts, Gordon P., Jr., Joshua Daniel and Robin Arnold

- 2009 A Phase I Remote-Sensing Archaeological Survey and Target Assessment of a Proposed Borrow Area Off Amelia Island, Nassau County, Florida. Report to Olsen Associates, Jacksonville, FL from Tidewater Atlantic Research, Washington, NC.

- 2009 Underwater Archaeological Survey Coleman Bridge Submarine Cable Project Yorktown & Gloucester, Virginia. Report to Virginia Department of Transportation, Richmond and College of William and Mary, Center for Archaeological Research, Williamsburg, VA from Tidewater Atlantic Research, Washington, NC.
- 2009 A Phase I Remote-Sensing Archaeological Survey of a Proposed Borrow Area at the Mouth of Bald Head Creek, Bald Head Island, Brunswick County, North Carolina. Report to Olsen Associates, Jacksonville, FL from Tidewater Atlantic Research, Washington, NC.
- 2009 Historical, Cartographic and Photographic Research and Reconnaissance Survey of a Section of Scuffletown Creek, Chesapeake, Virginia. Report to Craney Island Design Partners, Norfolk, VA from Tidewater Atlantic Research, Washington, NC.
- 2009 Historical, Cartographic and Photographic Research and Reconnaissance Survey of Sections of the Southern Branch of the Elizabeth River and Paradise Creek, Chesapeake and Portsmouth, Virginia. Report to Craney Island Design Partners, Norfolk, VA from Tidewater Atlantic Research, Washington, NC.
- 2009 A Site Location and Assessment Survey of Submerged Vessel 44CS0292 on the Southern Branch of the Elizabeth River Chesapeake, Virginia. Report to Bay Environmental, Chesapeake, VA from Tidewater Atlantic Research, Washington, NC.
- 2009 Submerged Cultural Resource Remote-Sensing Survey and Target Assessment Factory Point and Back River Hampton, Virginia. Report to URS Corporation, Newport News, VA from Tidewater Atlantic Research, Washington, NC.
- 2009 A Phase I Remote-Sensing Archaeological Survey of Three Proposed Borrow Sites East of Bodie Island, Dare County, North Carolina. Report to Coastal Science and Engineering, Columbia, SC from Tidewater Atlantic Research, Washington, NC.
- 2009 Cape Romano Shoals Submerged Cultural Resources Survey Cape Romano, Collier County, Florida. Report to Coastal Planning & Engineering, Boca Raton, FL from Tidewater Atlantic Research, Washington, NC.
- 2009 Historical Background Research and Terrestrial Archaeological Survey carried out in Conjunction with Proposed Onancock River Maintenance Dredging Project, Accomack County, Virginia. Report to U.S. Army Corps of Engineers-Norfolk District from Tidewater Atlantic Research, Washington, NC.
- 2009 Submerged Cultural Resource Remote Sensing Survey, Lesner Bridge Replacement Corridor, Lynnhaven Inlet, Virginia Beach, Virginia. Report to MAP Environmental, Virginia Beach, VA from Tidewater Atlantic Research, Washington, NC.
- 2009 Submerged Cultural Resource Survey for a Small Boat Dock Facility at the South End of the North Wharf, Military Ocean Terminal Point, Brunswick County, North Carolina. Report to U.S. Army Corps of Engineers-Wilmington District and Tetra Tech, Mobile, AL from Tidewater Atlantic Research, Washington, NC.
- 2009 Phase I Remote-Sensing Submerged Cultural Resource Survey of Offshore Borrow Sites located in Lafourche and Terrebonne Parish, Louisiana in Association with the West Belle Pass Barrier Headland Restoration Project. Report to Coastal Planning & Engineering, Boca Raton, FL from Tidewater Atlantic Research, Washington, NC.
- 2009 Submerged Cultural Resource Remote-Sensing Survey of Three Areas off Palm Beach, Palm Beach County, Florida. Report to Florida Bureau of Archaeological Research, Tallahassee from Tidewater Atlantic Research, Washington, North Carolina.

- 2009 Archaeological Remote-Sensing Survey of Eight Proposed Borrow Sites, Panama City, Bay County, Florida. Report to Coastal Planning & Engineering, Boca Raton, FL from Tidewater Atlantic Research, Washington, NC.

Completed in 2010

Watts, Gordon P., Jr., Joshua Daniel and Robin Arnold

- 2010 Archaeological Reconnaissance Investigation of Shipwrecks in the James River Adjacent to an Abandoned Wharf Structure East of City Point Hopewell, Virginia. Report to College of William & Mary, Center for Archaeological Research, Williamsburg, VA from Tidewater Atlantic Research, Washington, NC.
- 2010 A Phase I Archaeological Remote-Sensing and Probing Survey of Select Areas of Lawson Creek and the Trent River, New Bern, Craven County, North Carolina. Report Swiss Bear Downtown Development Corporation, New Bern, NC from Tidewater Atlantic Research, Washington, NC.
- 2010 Hard Bottom and Cultural Resource Surveys of Nearshore Areas off Bogue Banks and Shackleford Banks Morehead City Harbor DMMP, North Carolina. Report to U.S. Army Corps of Engineers-Wilmington District and Tetra Tech, Mobile, AL from Tidewater Atlantic Research, Washington, NC.

Joshua A. Daniel

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Washington, NC 27889
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Education

2009 Texas A&M University College Station, TX
M.A., Anthropology with an emphasis in Nautical Archaeology.

2003 University of Texas Austin, TX
B.A., Archaeological Studies.

Experience

2007-Present Tidewater Atlantic Research, Inc. Washington, NC

Senior Archaeologist/Field Supervisor

As a Senior Archaeologist for Tidewater Atlantic Research (TAR), Mr. Daniel is responsible for both fieldwork activities and management and operation of equipment. In this capacity, he operates and supervises the use of all survey equipment, including side scan sonars, magnetometers, sub-bottom profilers, global positioning systems, fathometers, tide gauges, and computers used for the collection of data during remote-sensing surveys. Mr. Daniel is also responsible for the initial analysis and interpretation of all remote-sensing data and assists in report preparation and graphics production. While employed at TAR, he has been involved in the excavation and digital mapping of numerous derelict vessels using the Vulcan Spatial Measurement System in conjunction with Rhinoceros, a three-dimensional CAD and modeling program. He also participates in the conservation, photography, and analysis of recovered artifacts. His software expertise includes Hypack, AutoCAD, ArcGIS, Rhinoceros, and SonarWIZ for the development of sonar mosaics, magnetic contour maps, and three-dimensional site plans.

Mr. Daniel has been involved in projects in various states, including Delaware, Virginia, North Carolina, South Carolina, Georgia, Florida, Louisiana, and Texas.

2007-Present Institute for International Maritime Research, Inc. Washington, NC

Senior Archaeologist

As the Senior Archaeologist for the Institute for International Maritime Research, Mr. Daniel has been involved in several projects, including the search for the Lost Colony on Roanoke Island. He was involved in the creation of a submerged cultural resources Geographic Information System for use by the Georgia Department of Natural Resources. Mr. Daniel is also responsible for the three-dimensional documentation of the *Ada Mae*, an early 20th century North Carolina skipjack.

August-November 2007 Queen Anne's Revenge Shipwreck Project Beaufort, NC

Archaeological Dive Technician

For three months, Mr. Daniel served as an archaeologist on the Queen Anne's Revenge Shipwreck Project. While working in this capacity, he assisted in the excavation, documentation, and recovery of artifacts from shipwreck 31CR314, believed to be the flagship of the pirate Blackbeard which sank in 1718.

Experience, continued

September 2005-
May 2007

Department of Anthropology

College Station, TX

Network Administrator

For two years, Mr. Daniel was in charge of administration and development of the Department of Anthropology's computer domain at Texas A&M University.

While in this position, he was responsible for all computer repair and procurement. He was the webmaster for the Department of Anthropology and co-webmaster for the Institute of Nautical Archaeology. During the last few months in this position, Mr. Daniel received a grant to provide the Nautical Archaeology Library with a server and a number of work stations in order to begin the process of digitizing the library's aging collections.

May-August 2005,
May-August 2006

Institute of Nautical Archaeology

Kızılburun, Turkey

Archaeological Supervisor

Roman Column Wreck

For six months between 2005 and 2006, Mr. Daniel served first as an archaeologist and then an archaeological supervisor during the excavation of a Roman column wreck in western Turkey. In addition to supervising an excavation area, Mr. Daniel participated in artifact photography, cataloguing, field conservation, data entry, camp construction and the removal of several 4-ton column drums and various heavy marble elements. He also aided in the operation of the Institute of Nautical Archaeology's two support vessels.

May 2005

Cairo Dashur Boat Project

Cairo, Egypt

Archaeologist

While working in Cairo, Egypt for three weeks, Mr. Daniel was in charge of measuring and drawing the hull timbers from boats 4925 and 4926 in the Egyptian Museum.

September 2004-
May 2005

Nautical Archaeology Program

College Station, TX

Computer Technician/Teaching Assistant

For nine months, Mr. Daniel was in charge of all computer repair for the Nautical Archaeology Program at Texas A&M University. He was the sole webmaster for the Nautical Archaeology Program and Institute of Nautical Archaeology websites. In addition, he served as a teaching assistant to Dr. Donny Hamilton in an Introduction to Historical Archaeology class. He also worked under Dr. Hamilton in the Conservation Laboratory, conserving and documenting the remaining artifacts from Port Royal, Jamaica.

June-July 2004

Episkopi Bay Survey

Episkopi Bay, Cyprus

Archaeologist/Dive Master

In 2004, Mr. Daniel served as an archaeologist and dive master for the Episkopi Bay survey. In addition to searching for shipwrecks between Akrotiri and Avdimou Bay, the goal of this survey was to define the submerged harbor works from the port of Kourion. A secondary goal was to determine the geographical extents of a harbor mole and determine its relation to the Ottoman invasion of the island in 1571. The results of this survey included the location and initial documentation of exposed cargo from a 7th century A.D. Byzantine wreck. Mr. Daniel was in charge of artifact drawing and photography, and aided in analysis and conservation of recovered artifacts.

Conferences

- The Society for Historical Archaeology
2010 A System for Mapping Historic Ships and Shipwreck Sites in Three Dimensions
- Computer Applications and Quantitative Methods in Archaeology
2009 Archaeological Documentation and Reconstruction of the 17A Derelict Vessel, Back River, Georgia
- Southeastern Archaeological Conference
2009 Location, Documentation and Reconstruction of a Vessel at the Combahee River Ferry Site, US Highway 17, Beaufort and Colleton Counties, South Carolina. (with Gordon Watts).

Poster Presentations

- “Kizilburun 2006”, International Awareness Week.
“Kizilburun 2006”, Student Research Week.

Reports and Publications

- In press. “Archaeological Documentation and Reconstruction of the 17A Derelict Vessel, Back River, Georgia.” *Making History Interactive. Proceedings of the 37th International Conference on Computer Applications and Quantitative Methods in Archaeology (CAA), Williamsburg, Virginia, March 22-26, 2009.*
- 2010 *Hard Bottom and Cultural Resource Surveys of Nearshore Areas off Bogue Banks and Shackleford Banks, Morehead City Harbor DMMP, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2010 *A Phase I Archaeological Remote-Sensing and Probing Survey of Select Areas of Lawson Creek and the Trent River, New Bern, Craven County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2010 *Archaeological Reconnaissance Investigation of Shipwrecks in the James River Adjacent to an Abandoned Wharf Structure East of City Point, Hopewell, Virginia.* (with Gordon Watts and Robin Arnold).
- 2009 *Phase I Remote-Sensing Submerged Cultural Resource Survey of Offshore Borrow Sites located in Lafourche and Terrebonne Parish, Louisiana in Association with the West Belle Pass Barrier Headland Restoration Project.* (with Gordon Watts and Robin Arnold).
- 2009 *Submerged Cultural Resource Remote-Sensing Survey of Three Areas off Palm Beach, Palm Beach County, Florida.* (with Gordon Watts and Robin Arnold).
- 2009 *A Phase I Remote-Sensing Archaeological Survey and Target Assessment of a Proposed Borrow Area Off Amelia Island, Nassau County, Florida.* (with Gordon Watts and Robin Arnold).
- 2009 *Submerged Cultural Resource Remote-Sensing Survey, Lesner Bridge Replacement Corridor, Lynnhaven Inlet, Virginia Beach, Virginia.* (with Gordon Watts and Robin Arnold).
- 2009 *Underwater Archaeological Survey, Coleman Bridge Submarine Cable Project, York and Gloucester Counties, Virginia.* (with Gordon Watts and Robin Arnold).
- 2009 *Final Report: Acadia Maritime Cultural Resources Inventory.* Report to Acadia National Park. Bar Harbor, ME. (with Franklin H. Price, Kristen Chasse and John Stallings).

**Reports and
Publications,
continued**

- 2009 *A Site Location and Assessment Survey of Submerged Vessel 44CS0292 on the Southern Branch of the Elizabeth River, Chesapeake, Virginia.* (with Gordon Watts and Robin Arnold).
- 2009 *Historical, Cartographic, and Photographic Research and Reconnaissance Survey of Sections of the Southern Branch of the Elizabeth River and Paradise Creek, Chesapeake and Portsmouth, Virginia.* (with Gordon Watts and Robin Arnold).
- 2009 *An Archaeological Remote-Sensing Survey of Sections of Scuffletown Creek, Chesapeake, Virginia.* (with Gordon Watts and Robin Arnold).
- 2009 *A Phase I Remote-Sensing Archaeological Survey of Three Proposed Borrow Sites East of Bodie Island, Dare County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2009 *Cape Romano Shoals Submerged Cultural Resources Survey, Cape Romano, Collier County, Florida.* (with Gordon Watts and Robin Arnold).
- 2009 *Archaeological Remote-Sensing Survey of Eight Proposed Borrow Sites, Panama City, Bay County, Florida.* (with Gordon Watts and Robin Arnold).
- 2009 *A Phase I Remote-Sensing Archaeological Survey of a Proposed Borrow Area at the Mouth of Bald Head Creek, Bald Head Island, Brunswick County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2009 *Submerged Cultural Resource Remote-Sensing Survey and Target Assessment, Factory Point and Back River, Hampton, Virginia.* (with Gordon Watts and Robin Arnold).
- 2009 *Underwater Survey and Vessel Evaluation, Bridge No. 188 on SR 1316 Over the Cape Fear River, Bladen County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2008 *Historical Background Research and Terrestrial Archaeological Survey Carried Out in Conjunction with Proposed Onancock River Maintenance Dredging Project, Accomack County, Virginia.* (with Gordon Watts and Robin Arnold).
- 2008 *Lido Key New Pass Anomaly Assessment Investigation, Sarasota County, Florida.* (with Gordon Watts and Robin Arnold).
- 2008 *Underwater Archaeological Remote Sensing Survey, Proposed SC 171 Bridge Replacement Corridors, Folly Island, Charleston County, South Carolina.* (with Gordon Watts and Robin Arnold).
- 2008 *Archaeological Mitigation at the 17A Derelict Vessel Site on Back River, Chatham County, Georgia.* (with Gordon Watts and Robin Arnold).
- 2008 *A Remote-Sensing Survey of a Proposed Borrow Area off Anna Maria Island, Manatee County, Florida.* (with Gordon Watts and Robin Arnold).
- 2008 *A Phase I Remote-Sensing Archaeological Survey of a Proposed Borrow Area off Amelia Island, Nassau County, Florida.* (with Gordon Watts and Robin Arnold).

**Reports and
Publications,
continued**

- 2008 *An Archaeological Remote-Sensing Survey and Target Assessment for a Borrow Area Offshore of Tybee Island, Chatham County, Georgia.* (with Gordon Watts and Robin Arnold).
- 2008 *A Submerged Cultural Resources Remote-Sensing Survey, New River Inlet Channel Realignment, Onslow County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2008 *Underwater Archaeological Remote-Sensing Survey at the Front Street Village Development Site on Taylor Creek, Carteret County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2008 *Archaeological Remote-Sensing Survey of the Harry S. Truman Parkway Bridge Corridor and Adjacent Waterways on the Vernon River, Chatham County, Georgia.* (with Gordon Watts and Robin Arnold).
- 2008 *Submerged Cultural Resources Remote Sensing Survey of a Borrow Area Located off New Topsail Inlet, Pender County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2007 *Underwater Archaeological Survey and Evaluation, Bridge Nos. 42 and 43 on U.S. 70 Business Over the Neuse River, Lenoir County, North Carolina.* (with Gordon Watts and Robin Arnold).
- 2007 *An Intensive Ordnance and Submerged Culture Resource Remote-Sensing Survey of Proposed Borrow Areas Off Willoughby Bank and Thimble Shoal Channel, Chesapeake Bay, Virginia.* (with Gordon Watts, Robin Arnold, Harry Pecorelli, and Frances Wilbanks).
- 2006 "An Egyptian Amphora from the Kizilburun Shipwreck." *INA Quarterly* 33.1: 13-14.

**Memberships
(Past and Present)**

Society for Historical Archaeology
Register of Professional Archaeologists
Texas Archeological Society